TECHNOLOGY DEPT

ROADS AND STREETS

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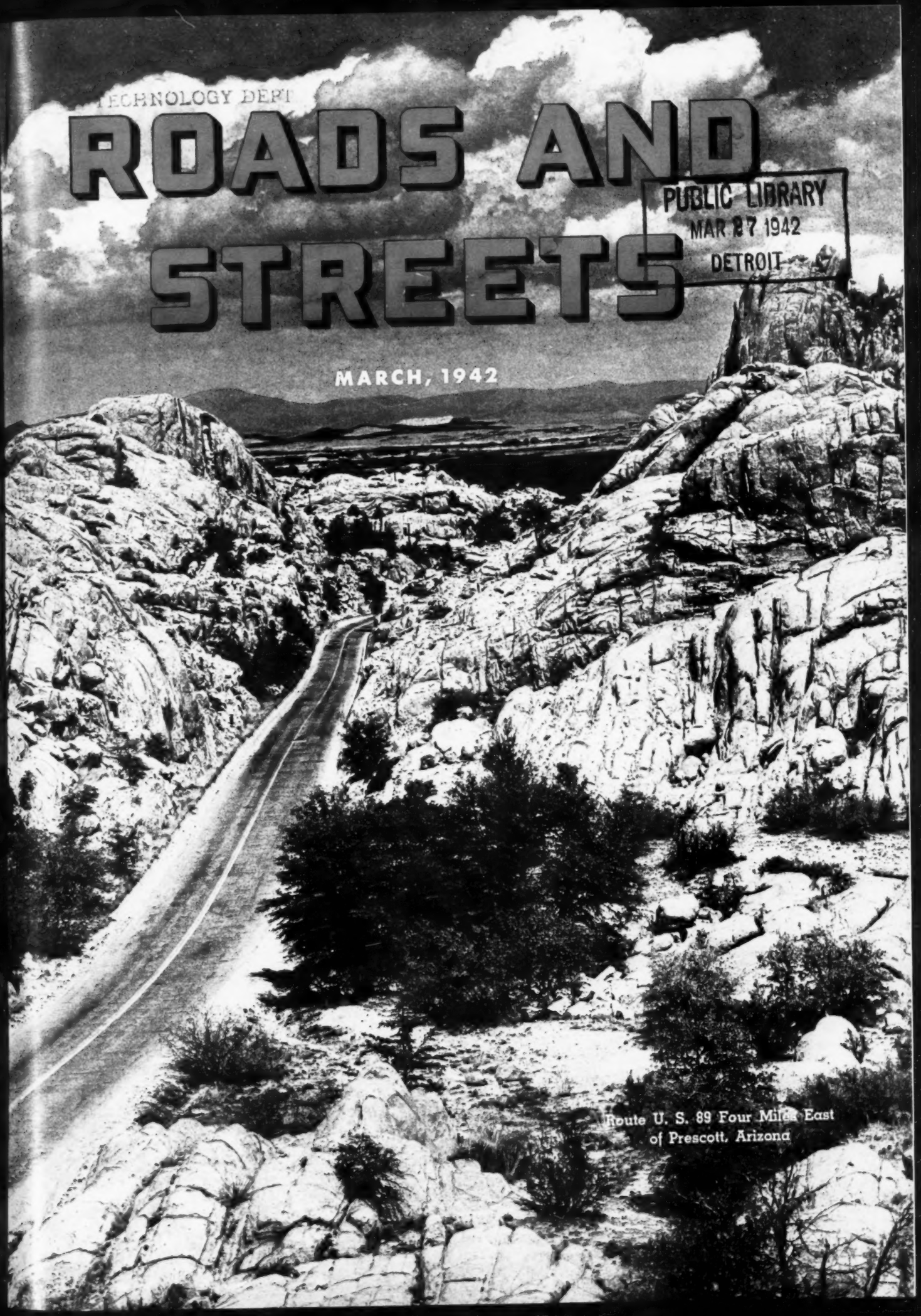
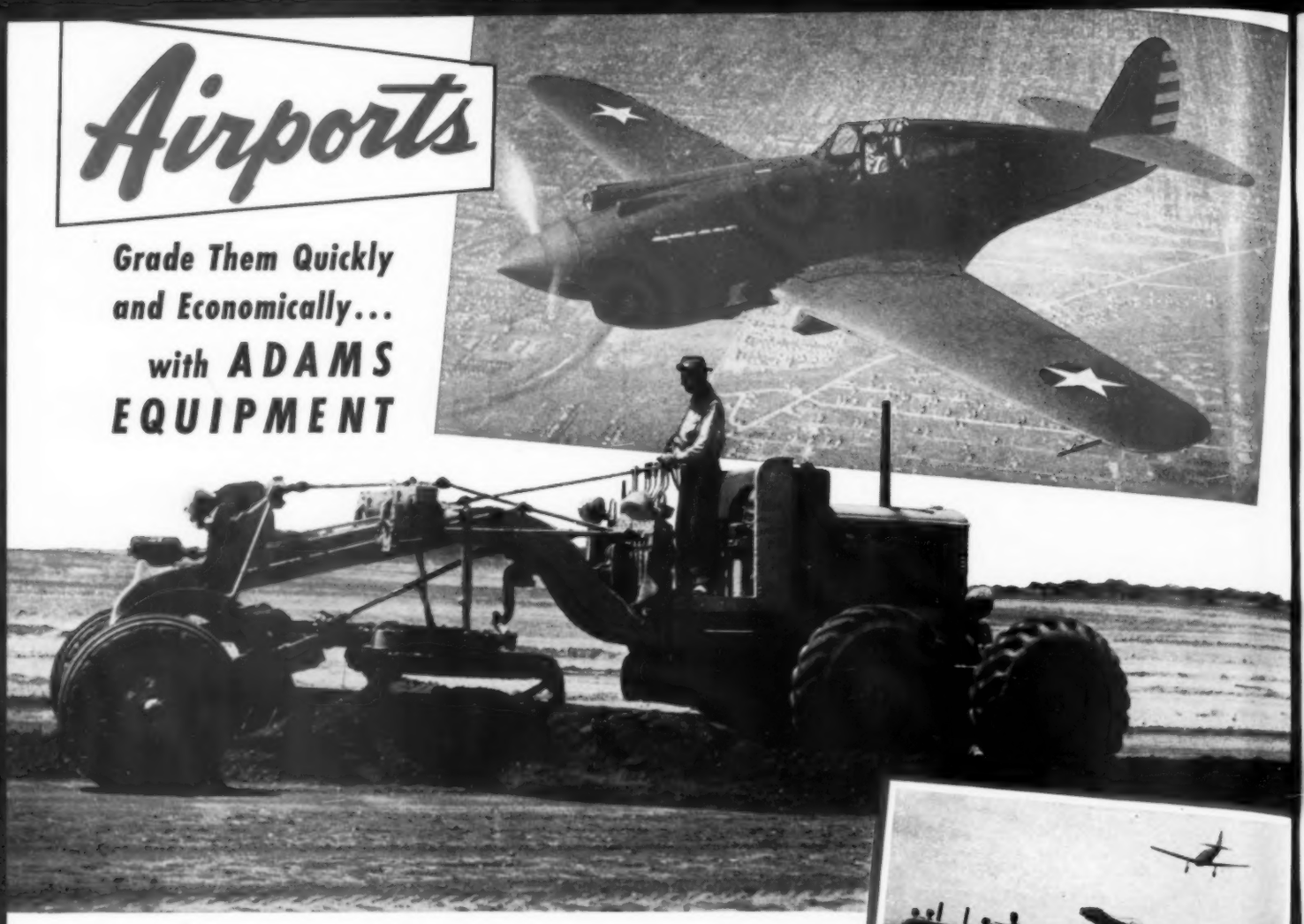


Route U. S. 89 Four Miles East of Prescott, Arizona

Airports

Grade Them Quickly and Economically... with ADAMS EQUIPMENT



IN THE vast airfield development program of the Army and CAA, hundreds of Adams machines are engaged in the necessary grading and all-around construction . . . Adams Hauling Scrapers level the ground on short haul work . . . Adams Elevating Graders cut down the grades on long and wide stretches, loading the material into trucks for use at more distant points . . . Adams Motor Graders build ditches for drainage, level off the cuts and fills, cut the runways to final grade and handle all necessary mixing and laying of black-top, soil-cement or other stabilized materials for use on runways, taxi-ways, and aprons.

No matter what your defense project, if it has road building or earth moving connected with it, see your nearest Adams dealer for any needed grading equipment. Wherever you are or wherever you go, Adams co-operative service is near at hand.

J. D. ADAMS COMPANY, INDIANAPOLIS, INDIANA

Sales and Service Throughout the World

ABOVE: *Adams Heavy-Duty Motor Grader (Diesel) grading runways on a California airport . . . A 12½-yd. Adams Hauling Scraper leveling grounds for an Oklahoma airport.*
BELOW: *An Adams Elevating Grader cutting grounds to grade on a large Alabama airport.*

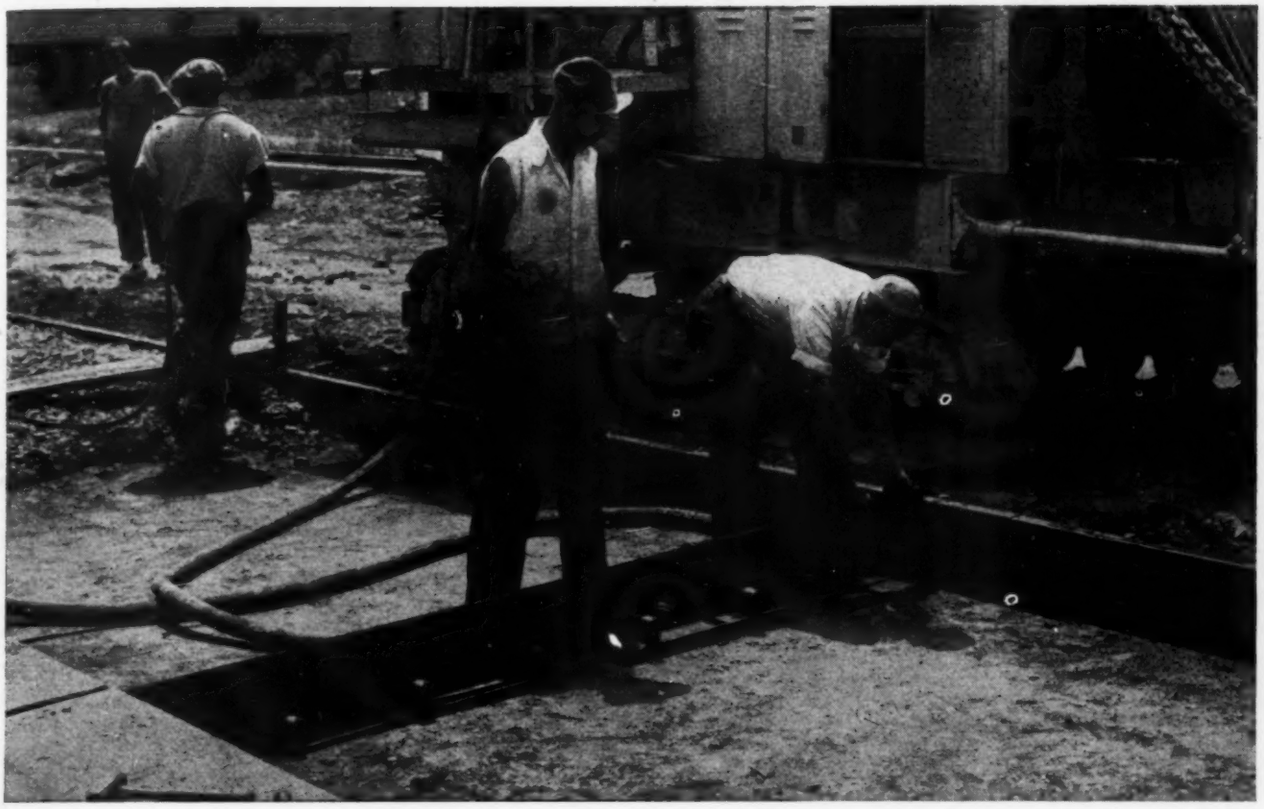
USE THESE ADAMS MACHINES—Motor Graders in six models, Leaning Wheel Graders, Elevating Graders, Hauling Scrapers, Tamping Rollers, etc.

ON THESE DEFENSE JOBS—Airfields, camps, defense building sites, ammunition dumps, access roads, etc.

ADAMS

ROAD-BUILDING AND EARTH-MOVING EQUIPMENT

Unload 'em...place 'em GET ON WITH THE JOB



Quickly, easily set in position by one or two men. Bethlehem Road Joints have equally strong support on each side of the filler mat so they won't tip over when the concrete is poured or finishing machine passes over them.

Bethlehem Road Joints come to you ready for instant placing, with dowels, caps, and chairs all assembled into one easily-handled unit. All you do is slip on the pre-cut fiber filler, set the assembly in place, and anchor with pins driven through the dowels. There's no time wasted locating, fitting and adjusting many parts together to form the unit.

Bethlehem Road Joints are made to hold their position, too. All dowels are shop-welded to steel spacing bars, parallel and carefully spaced. A third bar, welded to the tops of the dowels, stabilizes each unit and keeps the dowel firmly and accurately in place.

These dowels rest on the sub-grade with the base bars and form a solid support that resists displacement in any direction. Operators can drive finishing machinery over joints without displacing or disturbing them in any way.

Why not try Bethlehem Road Joints on your next job? See for yourself how they can speed up your placing, help you to finish contracts well within the time limit, and save you money as well. Phone or write Bethlehem Steel Company, Bethlehem, Pa., for more facts about them.

Bethlehem Road Steel Service

Many contractors avoid duplication of orders, as well as unnecessary accounting, letter-writing and follow-ups, by ordering all their highway steel through Bethlehem Road Steel Service:

Bar Mats Road Joints Reinforcing Bars
Dowels Dowel Bar Supports Bar Ties
Highway Guard Rails
Steel Highway Guard Posts
Guard Rail Anchor Rods
Bethlehem Beam Guard Rail
Bethlehem Sheet Piling and H-Piling

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL

ROADS AND STREETS

Vol. 85, No. 3 ▾ March, 1942

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ROADS AND STREETS

CCA

A magazine devoted to the design, construction, maintenance and operation of highways, streets, bridges, bridge foundations and grade separations; and to the construction and maintenance of airports.

WITH ROADS AND STREETS HAVE BEEN COMBINED GOOD ROADS MAGAZINE AND ENGINEERING & CONTRACTING

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There's Life in the OLD BABY YET★

Today you have more reason than ever before to be glad that shovels and cranes are built to last for years. Because, even though you find it difficult to obtain a new, modern shovel or crane, you'll also find that the designer of your present equipment has built into it lasting qualities that still enable it to maintain a high performance standard.

This is particularly true of owners of Thew-Lorain machines because of Thew's "Customer Protection" policy—a plan whereby all Thew-Lorain owners can keep their "old-timers" as up-to-date as man and modern materials can make them.

★ 11 years of hard service already under its belt and still battin' out big yardage for its owner in tough West Virginia rock.

THEW-LORAIN *Customer Protection*

Thew-Lorain engineers are developing continuously improvements and refinements to make Lorains even better units.

As these improvements are developed, it is Thew-Lorain's policy to design them, often at extra expense, so that they are applicable to as many machines outstanding in the field as possible.

Thus many of the improvements on the newest Lorains can be had for your machine. As you order repair parts, you often will receive newly designed and improved parts instead of the original and obsolete design.

To keep your Lorain right up-to-the-minute and offer you every new operating advantage, every chance to cut costs and maintenance; to keep you from having an out-of-date unit—and more important than anything else today, to "Keep 'em Digging"—that is what is meant by CUSTOMER PROTECTION.

Keep 'em Digging

30 Spare Parts Depots

Strategically Located for Quick, Efficient, Coast-to-Coast Service

THEW CENTER DRIVE

3/8 to 2 1/2 yd LORAINS

How You Can Move Earth Faster, Same Time Conserve Critical Materials and Manpower

use TOURNAPULLS

To get top loading efficiency from high speed scraper units use a pusher. On jobs like this defense airport, Tournapulls pusher loaded by a "Caterpillar" D8 tractor get heaping loads in 30 to 60 seconds.

Now more than ever America needs manpower . . . needs speed on the construction of war bases . . . needs critical materials—steel and more steel —for greater striking power. With Tournapulls, you can help supply all 3 needs, effectively and profitably.

More Speed, More Yardage

Because Tournapulls are quickly pusher loaded, haul at fast construction speeds (up to 14.3 m.p.h.), and spread their own loads, they move more yardage faster. Take a look at this Tournapull chart. Compare the yardages with what you get from older, conventional methods and equipment.

Haul One Way	98 H.P. Model C (11 yards heaped)		150 H.P. Super C (15 yards heaped)	
	Trips	Pay Yards	Trips	Pay Yards
600	17.1	150	15.0	180
1200	14.0	119	12.0	144
1600	12.3	104	10.7	129
2000	10.9	93	9.7	116
3000	8.4	71	7.6	91
5000	5.8	50	5.4	65

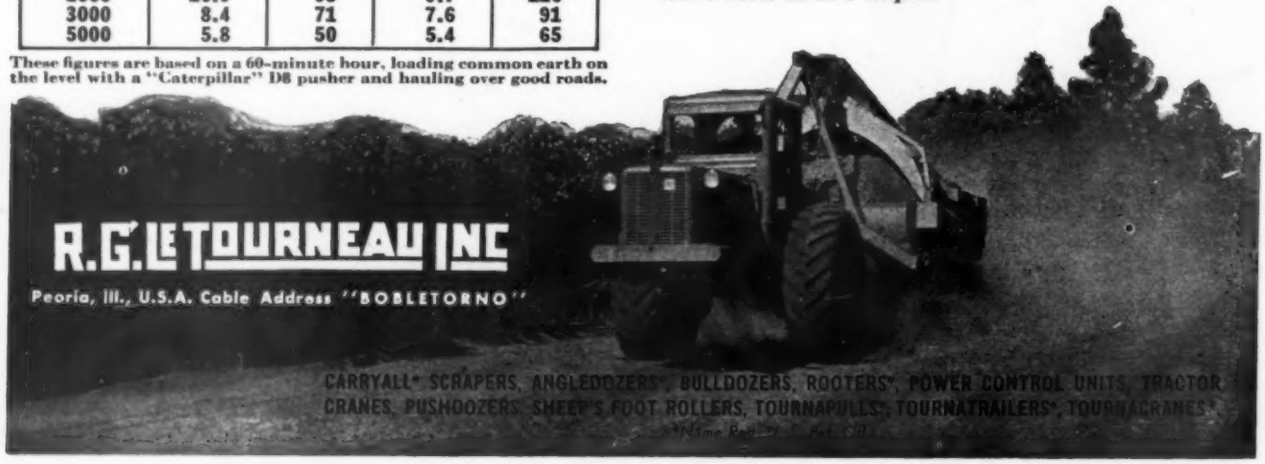
These figures are based on a 60-minute hour, loading common earth on the level with a "Caterpillar" D8 pusher and hauling over good roads.

147,000 Lbs. More Steel for Victory

As an example, take a 2000-foot haul over good construction roads. Here, because of their high average speeds, 2 Super C Tournapulls plus a "Caterpillar" D8 pusher (total weight 98,000 lbs.) will dig, haul and spread as much earth as a 2½-yd. shovel plus six 5-yd. trucks and a spreading dozer (totaling approximately 245,000 lbs.) That's a saving of 147,000 pounds of steel, vitally needed for victory. What's more, the Tournapull fleet requires 7 less men, cuts your equipment investment almost in half and reduces cost per yard approximately 54%!

Already more than 500 Model C and Super C Tournapulls are hurrying earthmoving projects here and abroad, mostly on defense. Use job-proved Tournapulls on your project to: (1) conserve manpower, (2) save steel, (3) speed defense, (4) lower costs. See your LeTourneau-"Caterpillar" distributor NOW for prices and delivery dates.

Quick loading, fast acceleration, spreading on the fly, enable you to get high average speeds over construction roads. This Tournapull working on a government arsenal travels at 14.3 m.p.h.



R. G. LeTOURNEAU INC

Peoria, Ill., U.S.A. Cable Address "BOBLETORNO"

CARRYALL* SCRAPERS, ANGLEDOZERS*, BULLDOZERS, ROOTERS*, POWER CONTROL UNITS, TRACTOR CRANES, PUSHDOZERS, SHEEP'S FOOT ROLLERS, TOURNAPULLS*, TOURNATRAILERS*, TOURNACRANES*

BAIRD CREEK BRIDGE
PROVES *Timber* CAN MAKE IT AND TAKE IT

A STORY OF ENGINEERING ACHIEVEMENT

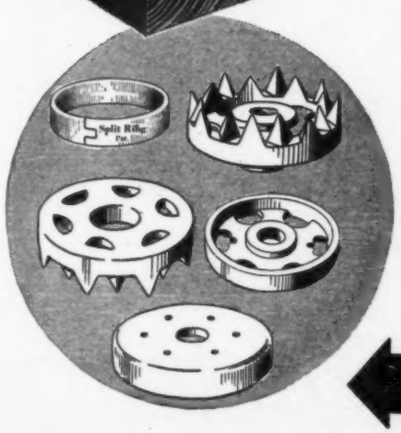
In Eastern Cowlitz County, Washington, is a modern masterpiece in timber trestle construction. The bent is 68 ft. wide at the bottom, 56 ft. wide at the top, and 3" x 10" ring connected bracing holds it together without any bolsters. Each brace has a TECO Split Ring Connector at each end connection. The bridge is 1,130 feet long and its rail height at the center point is 235 feet above the creek bed.

TECO Connectors are being used today in Roof Trusses, Overhead Cranes, Timber Bents, Trestles, Piers, Pier Foundations, Coal Pockets, Auto Loading Docks, Bridge Decks, Coaling Towers, and for many other types of construction.

TECO CONNECTORS gave the full strength of *Timber* to this TOUGH JOB

TECO Timber Connectors introduce a new technique to engineering. Because they relieve stress on timber joints by enlarging the bearing area, developing the full stamina of timber, they open many new fields to the basic economy of timber construction. Old-style plates, angles, and straps are eliminated; construction costs and maintenance expense are reduced.

TECO Timber Connectors are used today wherever enduring feats of engineering are being done. Mail the coupon now for complete technical details.



TECO Ring Connectors spread the load on a timber joint over practically the entire cross-section of the wood.

TIMBER ENGINEERING COMPANY INC.

DEPT. S-3, 1337 CONNECTICUT AVENUE

WASHINGTON, D. C.

Timber Engineering Co., Inc., Dept. S-3
1337 Connecticut Ave., Washington, D. C.

Please send us full technical information on the new design opportunities in timber made possible through the development of the Teco Connector System.

Individual.....

Firm.....

Street.....

City.....State.....

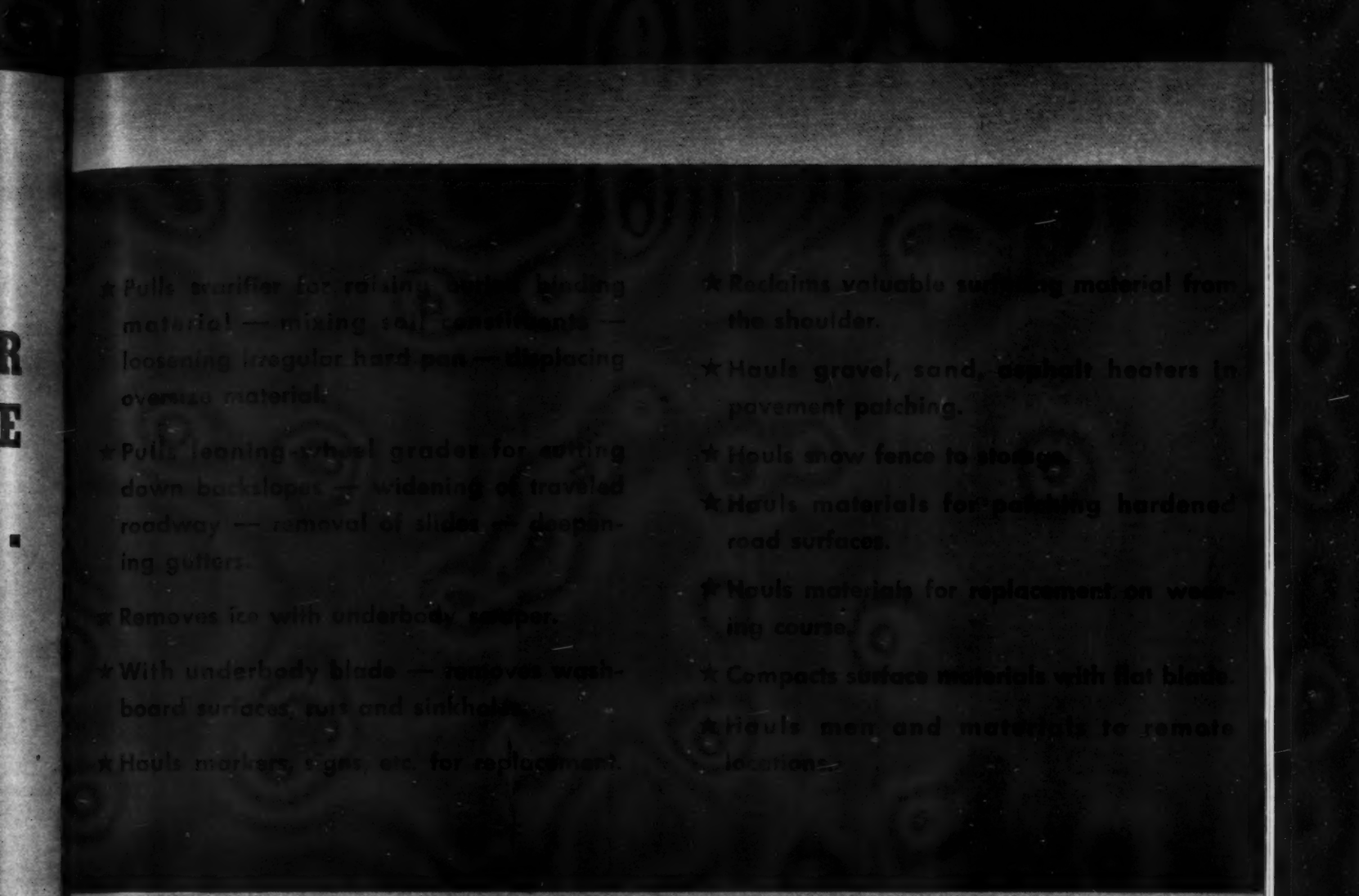
EARLY SPRING

ROAD JOBS THAT CAN BE DONE FASTER ...BETTER...AT LOWER COST...WITH THE *Model* H-G MAINTAINER...

FWD

FWD Model HG All-Season Maintainer — the most advanced four-wheel-drive truck built in America. A solid year of proving-ground tests has shown it to be a real truck engineering achievement — outstanding in pulling power, flexibility, and load-carrying ability.

★ PATROLS ROADS ★ HAULS MATERIALS ★ PLOWS SNOW


★ Pulls scarifier for raising buried loading material — mixing soil constituents — loosening irregular hard pan — displacing oversize material.
★ Pulls leaning-wheel grader for cutting down backslopes — widening of traveled roadway — removal of slides or deepening gutters.
★ Removes ice with underbody scraper.
★ With underbody blade — removes washboard surfaces, ruts and sinkholes.
★ Hauls markers, signs, etc. for replacement.
★ Reclaims valuable surfacing material from the shoulder.
★ Hauls gravel, sand, asphalt heaters in pavement patching.
★ Hauls snow fence to storage.
★ Hauls materials for patching hardened road surfaces.
★ Hauls materials for replacement on wearing course.
★ Compacts surface materials with flat blade.
★ Hauls men and materials to remote locations.

AS SOON AS THE *Frost Breaks!*

WHEN the spring breakup comes, highway departments swing into action with their FWD's—busy all winter clearing snow in the snow belt — patrolling and conditioning roads ravaged by winter's snow and ice. Listed above are just a few of more than 60 road conditioning and maintaining jobs that can be done faster — better — and at far less cost with the FWD Model HG All-Season Maintainer Truck.

Spring repair and conditioning is just one part of the four-season performance that keeps FWD's working in highway service every day of the year. Road men everywhere recognize the superior performance and capacity of FWD trucks . . . know that the four-wheel-drive principle, as applied in the FWD, provides a basically important advantage — qualifies it for a far wider range of usefulness — adaptability to a variety of road jobs that can only be accomplished by the full power and pull of four driving wheels.

Practically every type of road building and maintenance equipment has been utilized with FWD trucks—every known type of road grading and maintenance blade as well as special equipment are found on more FWD trucks than any other make of truck in the world. An investment in an FWD truck yields full return because of FWD's all-season usefulness — low maintenance and depreciation costs—and its ability to out-perform and out-work practically any other type of road maintaining equipment.

Investigate FWD trucks — write for full details today.

THE FOUR WHEEL DRIVE AUTO CO., Clintonville, Wis., U.S.A.

Canadian Factory: **KITCHENER, ONTARIO**

Ahead of the

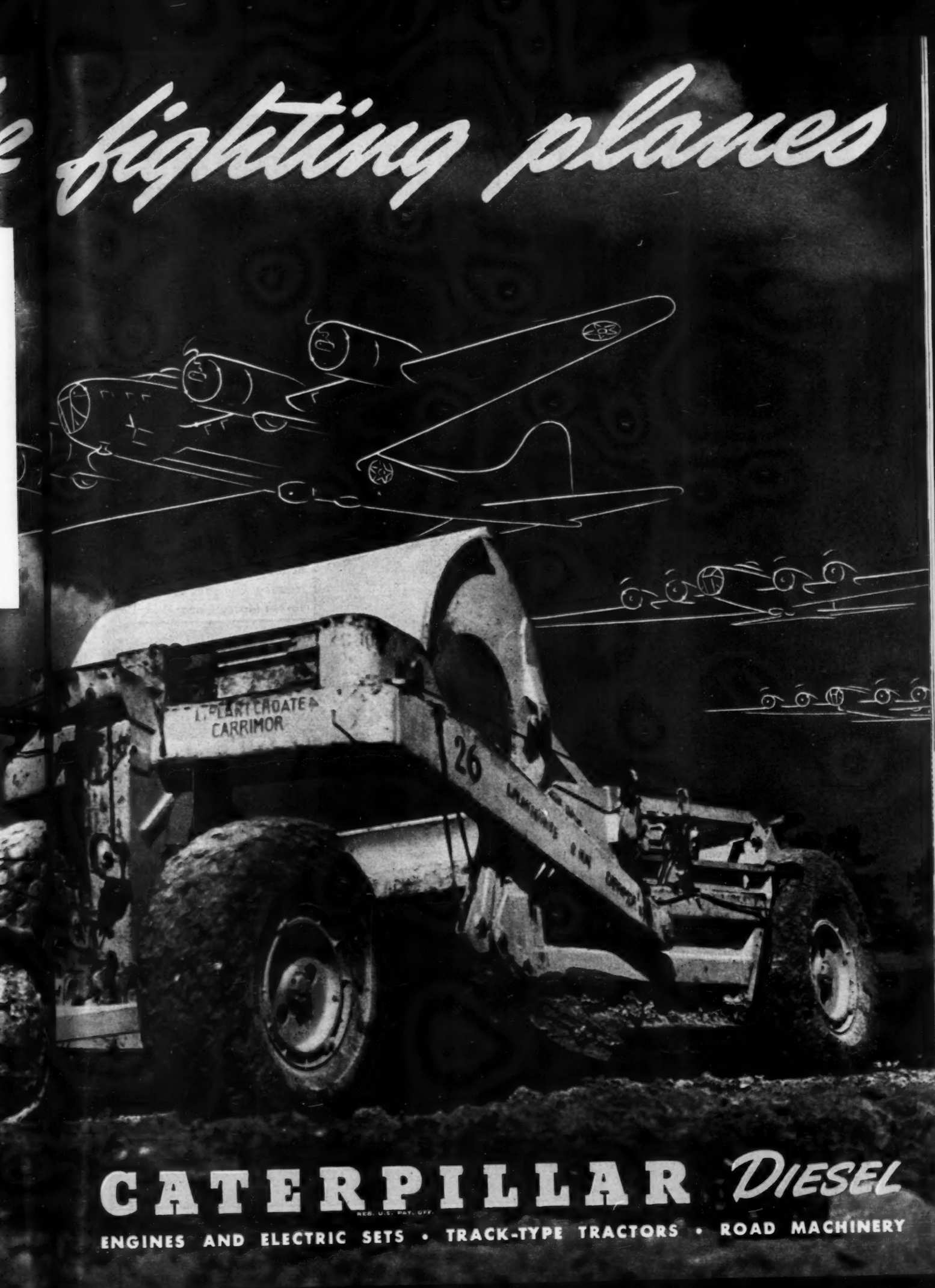
BEFORE the huge new Flying Fortresses, medium bombers and bullet-swift pursuit ships of our growing Air Force can be used to full advantage, they must have broad and level landing fields.

Those fields are being built today. Out of raw desert, forest and farmland, long runways are emerging swiftly. By the time the new planes and their pilots are ready, bases by the hundred will be waiting for them.

How is this tremendous task being accomplished? By the same tough "Caterpillar" Diesel Tractors, Engines and Motor Graders that have given America so many other advantages worth fighting for. In less than two years these brawny machines have done an unprecedented earth-moving job. Leveling hills and filling valleys, hauling giant scrapers and wagons, they have shifted countless millions of tons of dirt and rock to build highways, military and naval bases, air fields, industrial plants and shipyards.

The power, versatility and rugged stamina of "Caterpillar" Diesel equipment are vital factors in the nation's present effort. And they will be ready to help build a better world when the war is won. Caterpillar Tractor Co., Peoria, Illinois.

TO WIN THE WAR: WORK — FIGHT — BUY DEFENSE BONDS!


e fighting planes
CARRIMOR
26
CATERPILLAR
REG. U.S. PAT. OFF.
Diesel
ENGINES AND ELECTRIC SETS • TRACK-TYPE TRACTORS • ROAD MACHINERY

SNOW-BLOCKED ROADS *CAN* STOP AN ARMY!

Official Soviet Photo shows guns and armored vehicles abandoned in snow by retreating Germans Northeast of Moscow, near Klin.

Keep the Roads Open

WITH

WALTER

4-POINT POSITIVE DRIVE

SNOW FIGHTERS

The German disaster in Russia this past winter proves what cold weather and heavy snows can do to stop a powerful mechanized army. It holds an important lesson for America's highway officials charged with the vital job of keeping roads open for movement of war production, troops and supplies.

Above all, it emphasizes your need for WALTER SNOW FIGHTERS . . . the most powerful, dependable snow removal equipment available. They are specially engineered and constructed throughout for the punishing work of snow clearance They have the exclusive Walter 4-Point Positive Drive, with automatic lock differentials that proportion the torque to each wheel according to its traction—providing maximum power-plus-traction in all wheels, at all times, under all running conditions.

Other features which contribute to the power, stamina and performance of Walter Snow Fighters are: Suspended Double Reduction Drive with high ground clearance and greater reserve strength; 10-to-1 range tractor type transmission; powerful motors that develop rated H.P. at moderate engine speeds. Write today for detailed literature.

WALTER MOTOR TRUCK COMPANY

1001-19 IRVING AVENUE

RIDGEWOOD, QUEENS, LONG ISLAND, NEW YORK

FOR MODERN, SCALE-RESISTANT HIGHWAYS

These New Vinsol-Treated Cements Give You Truly Scale-Resistant Concrete That's Easier to Place and Finish

Pavement scaling has been successfully checked. Years of testing in more than a dozen northern states demonstrate that an answer has been found to this problem which now vexes all concerned with the design and construction of concrete highways.

VINSOL-TREATED CEMENT THE ANSWER

A new kind of cement—conditioned during manufacture with minute amounts of Hercules' Vinsol* Resin—is the answer. All tests to date show that concretes made from these conditioned cements are definitely more resistant to surface-scaling and the disintegration which so frequently results. In one typical test series, concrete pavement (*upper*) made with normal portland cement and subjected to accelerated ice-removal action, scaled over from 65 to 85% of the total slab area. Adjacent sections, made with Vinsol-treated cement, (*lower*) scaled over only 0 to 5% of the slab areas . . . in the same time and under the same rigorous conditions.

Scaling of Typical Concretes

Normal Portland

Vinsol-Treated

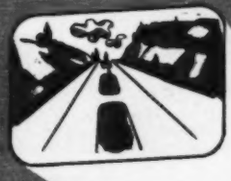
*Reg. U.S. Pat. Off.

EASIER WORKING, TOO

All types of frost scaling are apparently equally reduced. And, in addition, concretes made with these new cements show increased ease of placeability . . . are more workable . . . and segregation, bleeding, and the formation of pockets of mortar or aggregate are less apt to occur. These qualities permit the finishing crews to work closer to the mixer, completing the job faster.

GET THE FACTS TODAY

The facts on these Vinsol-treated cements have been proved by hundreds of tests. Cement companies, highway departments, contractors, all have verified the remarkable results these conditioned cements make possible. Many cement companies now offer special Vinsol-treated cements for construction which will be exposed to freezing temperatures. Thus, your regular cement supplier can probably give you all the information you need. If not, write us for a complete bibliography of the work to date. Address Naval Stores Department, Hercules Powder Company, 966 Market Street, Wilmington, Delaware.



BETTER ROADS AHEAD is the title of a 15-minute, 16mm., sound-and-color motion picture which documents some of the work done with Vinsol-treated cements from 1938 through 1940. If your group would like to view this film, a showing can be arranged by letter to us.

Use "Vinsol-Treated" Cement FOR Reduced Surface Scaling

NAVAL STORES DEPARTMENT
HERCULES POWDER COMPANY INCORPORATED
972 MARKET ST., WILMINGTON, DEL.

Gentlemen:
Please send information on Vinsol-treated cements.

Name _____

Address _____

City _____ State _____ LL-66

HOW TO "REFORM" TROUBLE-MAKING ROADS

This road *used to be* a "trouble-maker." Sidehill seepage water saturated the roadbed and caused excessive maintenance. Surface repairs were only temporary and had to be repeated year after year.

But the highway engineer had the answer. ARMCO Perforated Pipe was installed to intercept and remove groundwater. Today, thanks to a dry subgrade, the road has "reformed" and costs far less to keep smooth and safe. Moreover it will stay that way. An ARMCO subdrainage system stoutly resists crushing and disjointing. Flexible, corrugated metal design and strong, tight joints see to that. There is no need to worry about heavy loads, traffic vibration, shifting soils or severe frost action.

ARMCO Perforated Pipe is easy to lay in any season. Unskilled men do the work without special tools. Long lengths are quickly joined by sturdy band couplings to form a strong, trouble-free conduit. Cost is low and the job soon pays for itself in maintenance savings. Write us for all the time and money saving facts. ARMCO DRAINAGE PRODUCTS ASSOCIATION, 305 Curtis Street, Middletown, Ohio.

ARMCO **PERFORATED PIPE**

For the Unhampered Movement of Men and Materials...

With the Nation's resources mobilized for the efficient, all-out prosecution of the war, the country's vast network of highways takes on a new significance. It is on them that the speedy movement of men and materials depends.

Practically every important highway in the United States has felt the influence of MARION equipment. Marions excavate or clear for new right-of-ways — place steel or concrete on bridges, tunnels and overpasses — and handle materials for final construction.

Today MARION'S dependable performance is being utilized by hundreds of contractors in an all-out "blitz" against TIME in building more highways. In this way MARION is bringing defeat closer to the enemies of democracy.

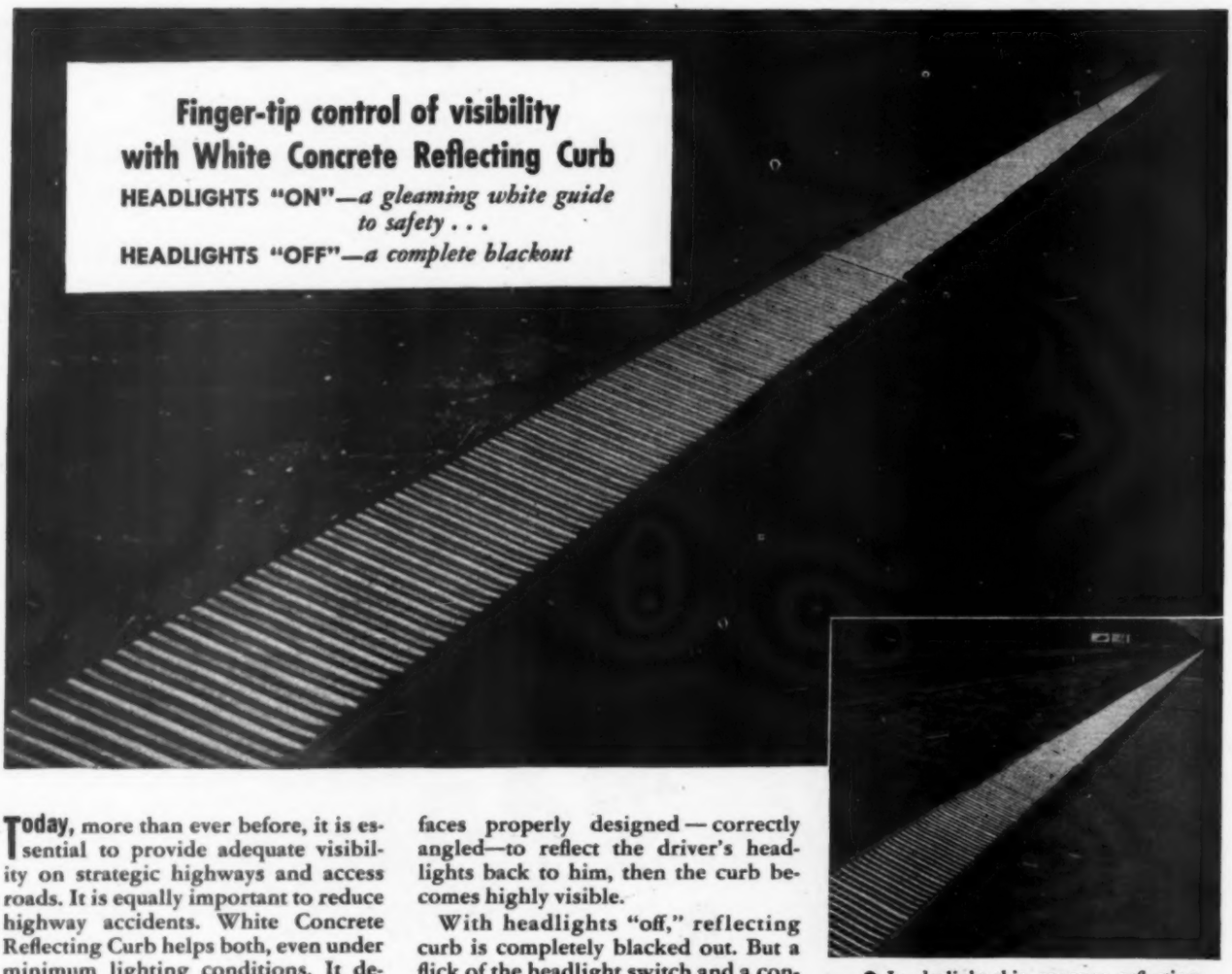
THE MARION STEAM SHOVEL COMPANY
MARION, OHIO, U. S. A.

Offices in all principal cities
Serving industry since 1884

MARION

SHOVELS • DRAGLINES • CLAMSHELLS
CRANES • PULL-SHOVELS • WALKERS
Gasoline — Diesel — Electric — ¾ cubic yard to 35 cubic yards

HOW TO IMPROVE VISIBILITY of strategic highways and access roads


Finger-tip control of visibility
with White Concrete Reflecting Curb
HEADLIGHTS "ON"—a gleaming white guide to safety . . .
HEADLIGHTS "OFF"—a complete blackout

Today, more than ever before, it is essential to provide adequate visibility on strategic highways and access roads. It is equally important to reduce highway accidents. White Concrete Reflecting Curb helps both, even under minimum lighting conditions. It depends upon headlight rays—no other illumination is needed—to provide visibility.

Your rear-view mirror tells the secret. Only when placed at the *correct angle* does it reflect to you the car behind you —make it visible. So also with curb. If smooth, it reflects the driver's headlight rays in the wrong direction—at the wrong angle. The reflection is wasted. Visibility of the curb is poor. But when the curb has "saw-toothed" faces properly designed — correctly angled—to reflect the driver's headlights back to him, then the curb becomes highly visible.

With headlights "off," reflecting curb is completely blacked out. But a flick of the headlight switch and a continuous ribbon of light defines the highway for the driver, far ahead of the car.

THIRTY-TWO-PAGE BOOK, complete with photographs, illustrations, working drawings and specifications, tells the fascinating story of this new safety curb. Send today for a "A WHITE GUIDE TO SAFETY." Write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Bldg., New York City.

● In daylight this concrete reflecting curb made with Atlas White Cement dominates the highway. On a rainy night (top) it is a brilliant white guide to safety along the blacked-out roadway. Reason: The scored finish reflects car headlight rays directly back to the driver's eyes and the white concrete curb stands out in sharp contrast to the surrounding blackness.

OFFICES: *New York, Chicago, Philadelphia, Boston, Albany, Pittsburgh, Cleveland, Minneapolis, Duluth, St. Louis, Kansas City, Des Moines, Birmingham, Waco.*

RS-M-28

WHITE CONCRETE REFLECTING CURB

MADE WITH ATLAS WHITE CEMENT

Now more than ever you need BAKER Hydraulic Bulldozers

★ Greater Output — direct down pressure, easier control, greater moldboard area score bigger yardages every shift.

★ Less Maintenance—they'll do more with less wear and tear on the tractor, the hydraulic power unit and the bulldozer; conserving manpower and vital replacement parts, aiding greatly in defense.

★ More Flexible—three different moldboards fit one frame; can be changed in a few minutes —straight board for "cut and fill"; curved, boxed-end board for excavators; angle board (to left or right) for gradebuilding.

★ Complete Line — 7 bulldozer models with corresponding gradebuilder and excavator moldboards for gasoline and diesel tractors of any horsepower. See them at work on every type of construction project in Bulletin 834.

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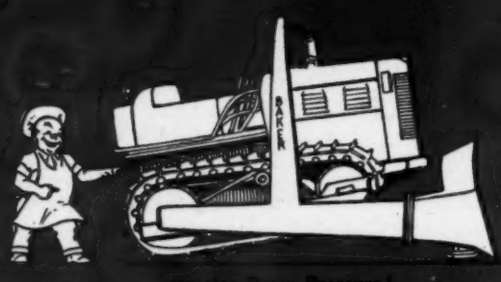

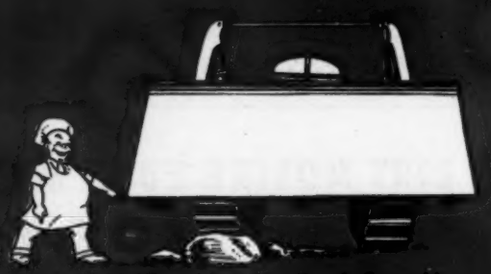

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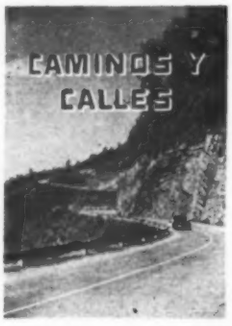

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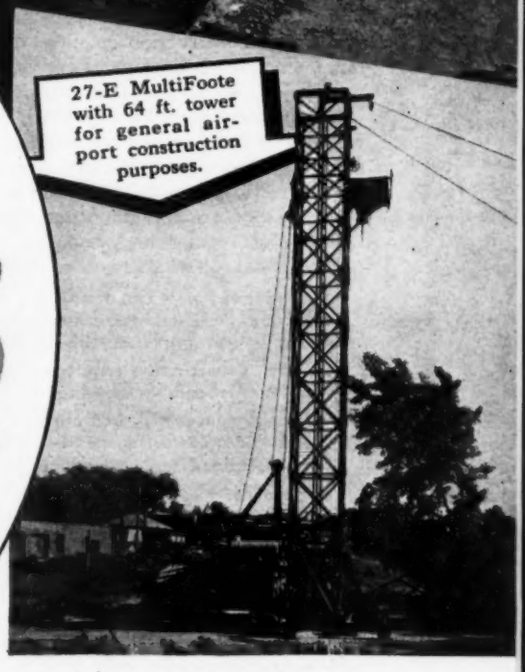

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ROADS AND STREETS

March, 1942, Vol. 85, No. 3

Soil Mechanics Studies and Reconstruction Work

Swedish Analysis Applied at Critical Section to Protect Pumping Station

By **VICTOR J. BROWN**
Publishing Director, ROADS AND STREETS

GRAPEVINE Grade on U. S. 99 out of the San Joaquin Valley in California through the Tehachapi Mountains to Los Angeles was partly rebuilt this past season and is now nearing completion. The section, figure 1, to be discussed in this article is in Kern County between Fort Tejon and a point one mile north of Grapevine Station. The reconstructed section on this long six percent grade (which is only part of a much longer grade) passes the pumping station of the General Petroleum Company. Recognizing old slide conditions along this route, the California Division of Highways made studies of the possibilities of future sliding which might occur from cutting or disturbing the natural slopes as they existed. On December 20, 1940, the Griffith Company of Los Angeles was awarded a $385,000 contract for grading through the six miles of Grapevine Canyon. The work on this contract not only includes the construction of a grade wide enough for a four lane divided highway but also for correction of the areas where slides were giving trouble or were imminent. A three lane road existed here prior to reconstruction. Increased traffic volume, sliding hill-

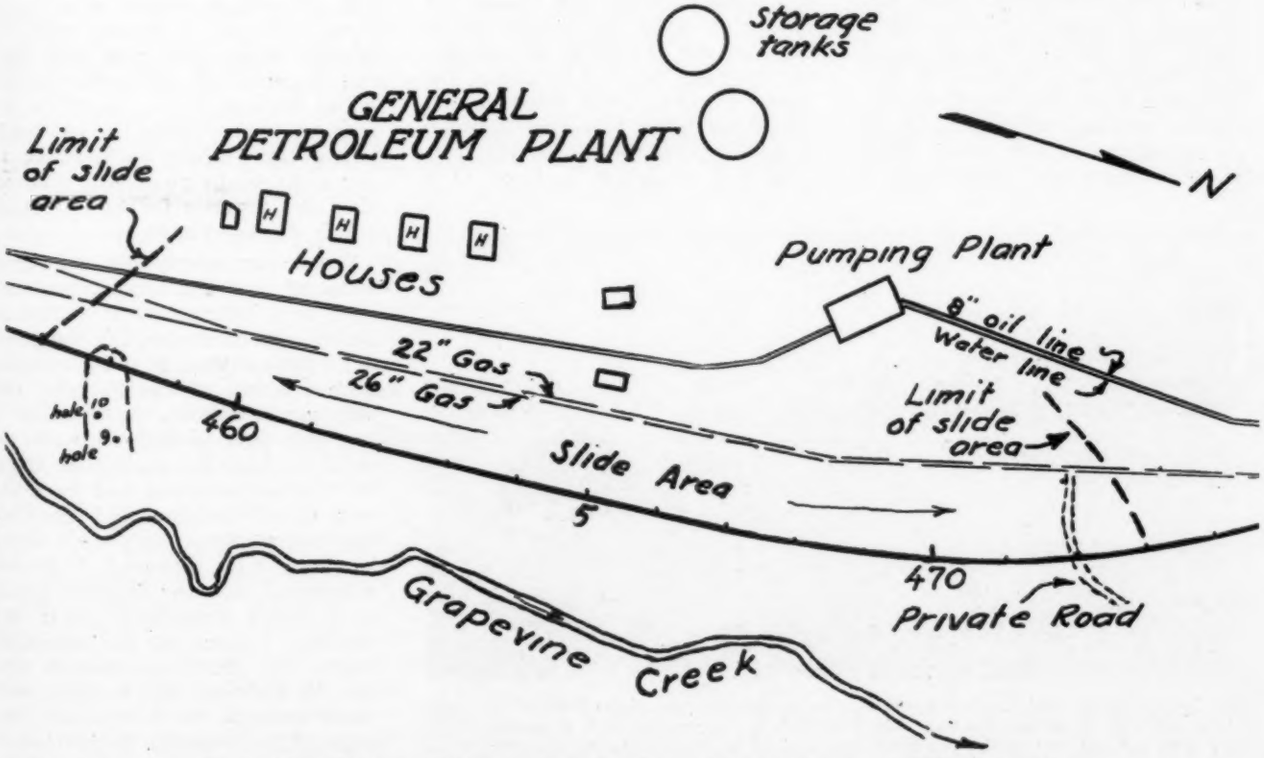


Fig. 1.—Plan sketch of critical area where slide was possible and where a minor slide occurred

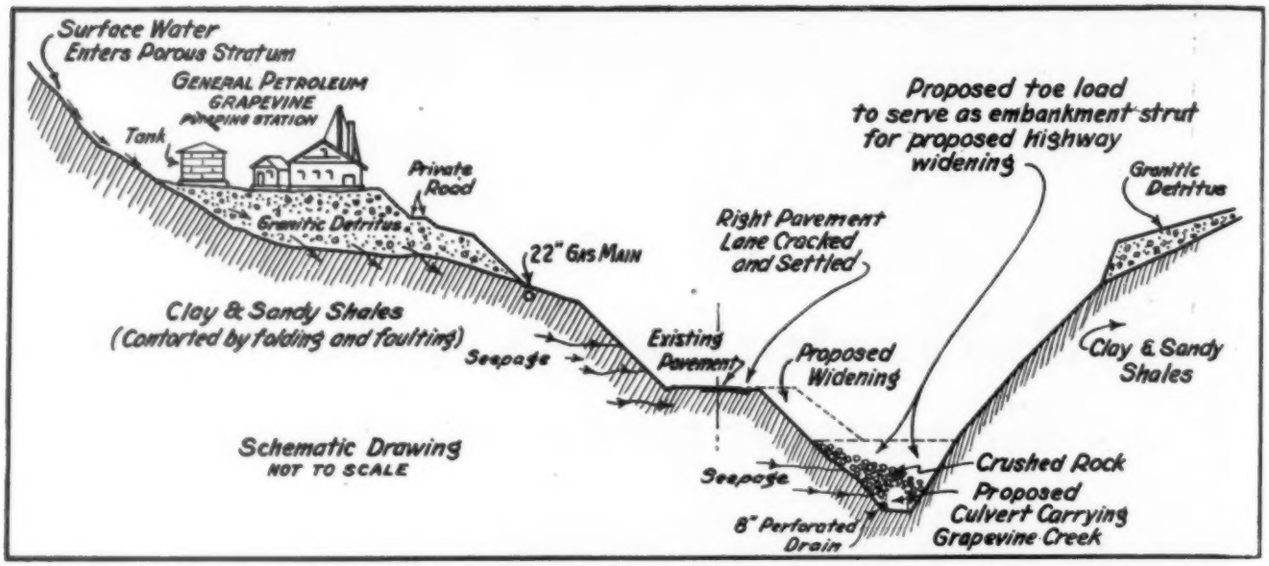


Fig. 2.—Schematic drawing of the critical section at Station 467. This drawing is not to scale. It shows how surface water enters the mountain side and appeared as seepage lines in slide areas

sides, a definite need for traffic space, and the excessive maintenance costs of this section indicated the demand for reconstruction.

Preliminary Investigational Work

Before any reconstruction began it was necessary to investigate the soil conditions all around the area of the pumping station where some cut-bank sliding had occurred. The Department of Materials and Research sunk many test holes to determine the character of the soil and the ground water conditions in this critical area, from about Station 458 to Station 474. Boring disclosed plastic clay subsoils carrying 30 to 45 percent of moisture. In general the formation consists of thin layers of porous sandy and silty strata which are interbedded with thick strata of soft blue and black clay and silty clay. Where the formation has been freshly exposed in the banks by erosion, it appears that the beds are approximately level, leading to the conclusion that the strata are much more recent than the distorted and faulted shales encountered in the major hills adjacent to the canyon.

The general treatment of large slides involves, as well as drainage of the substrata, the construction of embankment toe loadings and embankment struts where possible. In this case, to provide for toe load and embankment strut, the channel of Grapevine Creek would have to be filled. As will be seen by the schematic drawing, figure 2, a study was made in which it was proposed that Grapevine Creek be carried through a culvert under the toe loading. This plan was discarded in favor of a plan in which the creek is carried in an open, paved flume on top of the toe load, see figure 8. The toe load also serves as an embankment strut in this case. The picture, figure 3, shows the creek bed and pumping station location before reconstruction began.

A small draw runs up the hillside above the pumping station. Consideration was given to constructing a cut off trench from Station 459 to Station 466, approximately 25 ft. in depth at a point approximately 800 ft. left (up the hillside) of Station 464. An outflow trench would also have to be built to remove collected seepage water. This plan was discarded in favor of one in which horizontal borings would be made at frequent intervals into the cut bank to a distance which would intercept any probable slip plane. The adopted plan also provides for vertical sand drains, discussed later.

Plastic clay interbedded with thin lenses of sand and silt was encountered to a depth of 40 ft. Sufficient seepage was encountered in test holes to fill some of them to 18 ft. from the surface within 30 minutes after the hole was completed. Observations a few days later showed the water to be 12 ft. from the surface or about 35 ft. above the elevation of the roadway. All of the brown and blue clay encountered below the ground water level was fully saturated. It is not anticipated that any drainage treatment would appreciably lower the moisture content of the saturated plastic clay found interbedded with the silt and sand in the upper terraced deposits. It is expected that most of the moisture in the clay in this bank would be held by capil-

Fig. 3.—Area where slide analysis was made. The pumping station of the General Petroleum Company is shown on the mountain side. The ditch in the foreground is Grapevine Creek and is on a 6 per cent grade. This ditch was filled 30 ft. in providing an embankment toe load and at the same time an embankment strut

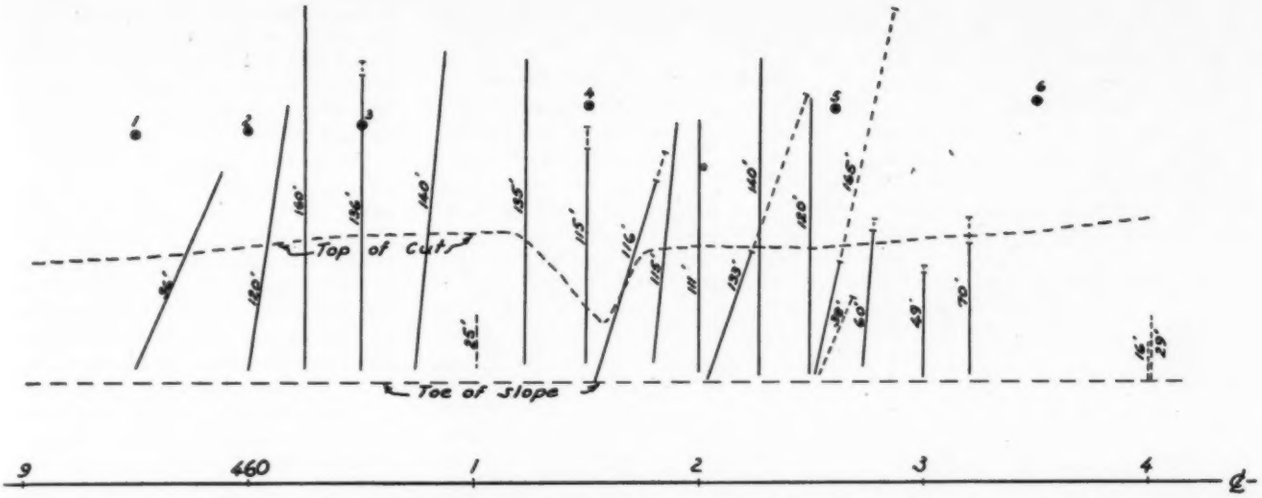


Fig. 4.—Horizontal sub-drainage holes drilled between stations 459 + 50 and 464 in which 2 in. perforated metal pipe have been jacked. The dotted lines indicate lengths lost in which it was unable to jack the pipe. Perforations on one-half of the pipe and placed upward when jacking into place. The points labeled from 1 to 6 are one inch vertical holes drilled to check subsurface water level when desired

larity even though the ground water level was dropped 20 to 30 ft. The upper 10 or 15 ft. of the deposit as well as the material near the surface of the cut slope will dry, however, as a result of summer evaporation when the ground water level is lowered.

The main benefit to be derived from sub-drainage treatment of the cut slope is to lower the ground water level and to eliminate the hydrostatic pressure and seepage forces which weaken the internal forces that resist sliding, i.e., the ground water conditions in this soil tend to aid the driving forces that cause sliding. It is estimated that 4000 lin. ft. of horizontal perforated metal pipe will be required between stations 459+50 and 465 to drain the cut slopes. Another 2500 to 3500 lin. ft. of horizontal drains will be required for treating limited seepage areas in both cuts and fills between Station 465+50 and 477, Grapevine Station. Horizontal drains installed in this section at this writing are shown by figure 4. Construction started on these holes on Dec. 15, 1941. By Jan. 23, 1942, about 20 drains were installed. The summation of their flow is approximately 13,000 gal. per day.

Added Safety Factor

A sketch showing various possible slide curves at the critical point near Station 467 is shown in figure 5. Figure 6 shows the site before reconstruction with work as finally accomplished sketched onto the photograph. The curves in figure 5 show the effect of a 30-ft. and a 50-ft. height of embankment toe load. In so far as slippage from below the pumping plant is concerned (curves 1 and 2) it will be noted that a 30-ft. height of toe load will increase the present stability by approximately 20 percent (curve 2a), whereas a 50-ft. fill (curve 2b) indicates a safety factor of 1.33 or a 33 percent increase over the present condition.

In view of the fact that the trouble up to the time the studies were made (just prior to reconstruction) was confined to settlement (as shown on the pavement surface in figure 7) and minor side slippage of the highway fill (curve 3) and to some slides into the highway from a point near the 22-in. gas line, as shown in figure 7, and further that there was no evidence of movement on any major slippage plane starting at the pumping plant and extending to the creek (near curves 1 and 2) it was decided that a 20 percent increase in resistance to sliding over the apparent state of stability was sufficient to amply safeguard the pumping plant. The 30-ft. toe load fill also provided ample safety against slippage of the highway fill into the creek as depicted by curves 3a and 4a.

Since the pumping plant was not

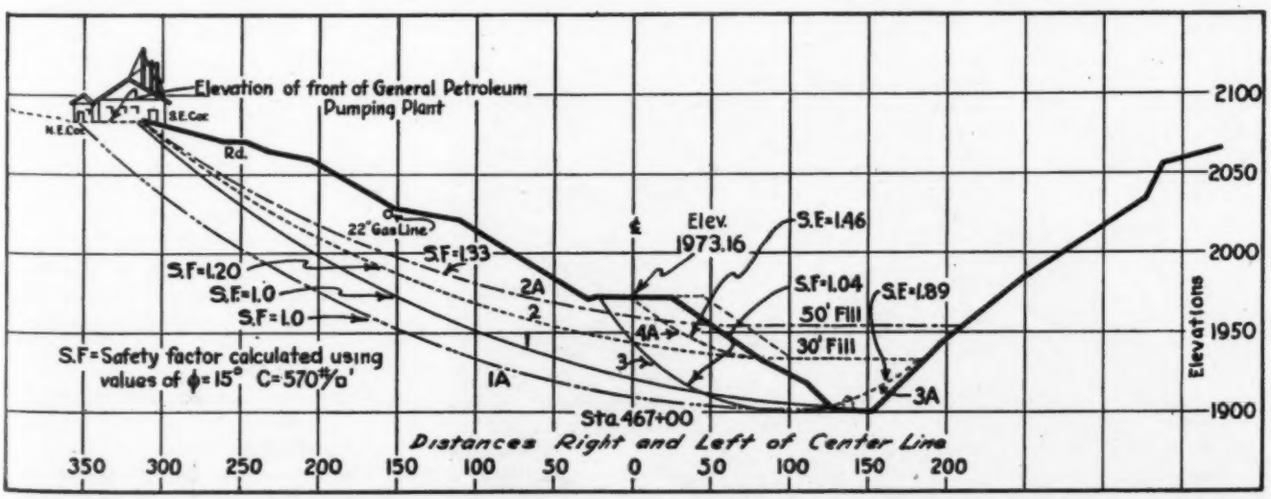


Fig. 5.—Analysis of probable slide curves at the critical section at station 467 below the pumping station of the General Petroleum Company showing effect of toe load fills. Value derived by virtue of toe load also acting as an embankment strut is not considered. This value is additional safety factor

disturbed at all by sliding, and the hill was at rest, it was assumed that a safety factor of at least 1.0 was applicable under the then existing conditions. Because there was (or is) no way of determining the safety factor of the formation as a whole, in analyzing the situation the soils engineers used values of cohesion and internal friction which resulted in a safety factor of 1.0 for the existing conditions. These calculations are shown later. The true safety factor will be higher than calculated because of the effect of the embankment strut (as a separate force from the toe load) and because of the horizontal subdrainage pipe driven back to the approximate location of curve 2a. As indicated by table I, a value of internal friction of 15 degs. for a factor of safety of 1.0 employs a value of 570 lb. per sq. ft. for cohesion. As the angle of internal friction increases, due to dewatering of the subsoils, the safety factor increases. This, added to the effect of the embankment strut, gives an added margin of safety to the pumping plant.

Analysis of Safety Factor

The Department of Materials and Research of the California Division of Highways employed the Swedish method of analysis to the critical section at Station 467. The cross section at the critical point where it is desired to analyze the possibilities of sliding is plotted. In this case it was drawn to a 20-ft. scale. A cross sectional slice, one foot thick at the point of analysis is employed. Starting each way from the center line of the roadway, the slice is divided into 20-ft. sections. These are numbered from 1 to 22 on figure 8. Curve 2 of figure 4 is the one for which calculations, and data in table I, are made in this article. All of the curves in figure 5 were calculated by the procedure shown here.

After dividing into 20-ft. sections the depth through the center of gravity of each section is scaled and plotted as a vertical vector from a point on the slip curve directly below the center of gravity of the numbered chunk. Normal and tangential vectors are then drawn to close the triangle. The normal vectors are called N and the tangential vectors are T.

Curve 1 is shown on this chart, and is the same curve as curve 1 in figure 5. It is the most dangerous curve on which sliding, if it could or might happen, would affect the pumping plant. But, as stated before, the hill is at rest and there was (or is) no evidence of sliding on this curve, so the value of 1.0 for safety factor is the minimum that exists. It may be much more, but since ground water levels were high and since some sliding on the cut bank occurred, reconstruction and additional protection against sliding, because of the highway cut having disturbed the natural condition, was considered necessary.

Having drawn all of the vectors for each chunk of the section, the N and T values were scaled and tabulated as in table I.

Fig. 6.—View of Grapevine hill area with proposed reconstruction sketched on the photograph. The toe load is labeled "Buttress Fill" on this picture

TABLE I.

Normal and Tangential Values, Scaled Vectors, Curve 2.

Chunk No.	N	T
1	4.5	4.0
2	11.5	9.0
3	18.0	13.0
4	26.0	17.0
5	33.0	20.0
6	40.5	22.0
7	42.0	22.0
8	42.0	20.0
9	41.0	18.0
10	44.0	18.0
11	47.0	17.0
12	44.0	14.0
13	39.0	11.0
14	33.0	9.0
15	27.5	6.0
16	30.5	6.0
17	34.5	6.0
18	37.0	5.0
19	37.0	4.0
20	26.0	1.0
21	13.0	1.0
22	4.0	0.0
	Total 675	243

In calculating values, the soil was taken at 120 lb. per cu. ft., and the width of the section was 20 ft.

The total normal force

$$= (675)(120)(20)$$
$$= 1{,}620{,}000 \text{ lb.}$$

The total tangential or driving force

$$= (243)(120)(20)$$
$$= 583{,}200 \text{ lb.}$$

The measured length of the slip curve (curve 2) is 460 ft. Average unit forces for N and T would then be

$$N = \frac{1{,}620{,}000}{460} = 3{,}522 \text{ lb. per sq. ft.}$$

$$T = \frac{583{,}200}{460} = 1{,}268 \text{ lb. per sq. ft.,}$$

the driving force on the slip plane.

Calculating for C.—Since curve 1

was taken to represent a condition with a safety factor (*SF*) of 1.0, and tests and experience indicated that a value of Φ for internal friction would be at least 15 degs., it remained to determine what value for *C*, cohesion, would satisfy the equation of stability. The forces resisting sliding are cohesion, *C*, and internal friction, $N \tan \Phi$. The values *N* and *T* on curve 1, calculated as above, are $N = 4{,}590$ lb. per sq. ft., and $T = 1{,}800$ lb. per sq. ft. The driving force for a condition of soil at rest, held by shear and cohesion, but with sliding imminent is represented by the formula, $T = C + N \tan \Phi$. In this case, *T* is less than *S* (shear) because the hillside is at rest. For a safety factor of 1.0, the equation becomes

$$SF = \frac{C + N \tan \Phi}{T} = 1.0$$

or,

$$C = T - N \tan \Phi$$

Substituting curve 1 values, the equation becomes

$$C = 1800 - 4590 \times 0.268$$
$$= 570 \text{ lb. per sq. ft.}$$

As a matter of interest it should be stated that while bridge designers employ factors of safety of 4 and 5, soils engineers seldom obtain safety factors higher than 1.5, or a 50 percent additional benefit.

It will be noted that curve 1 represents a condition of no toe loading of the embankment or possible slide.

Calculating Safety Factor of Curve 2.—The safety factor for curve 2 is calculated on a slip curve drawn to the top of a 30-ft. toe load placed on the lowered end of curve 1 slip plane. It is calculated as follows from the

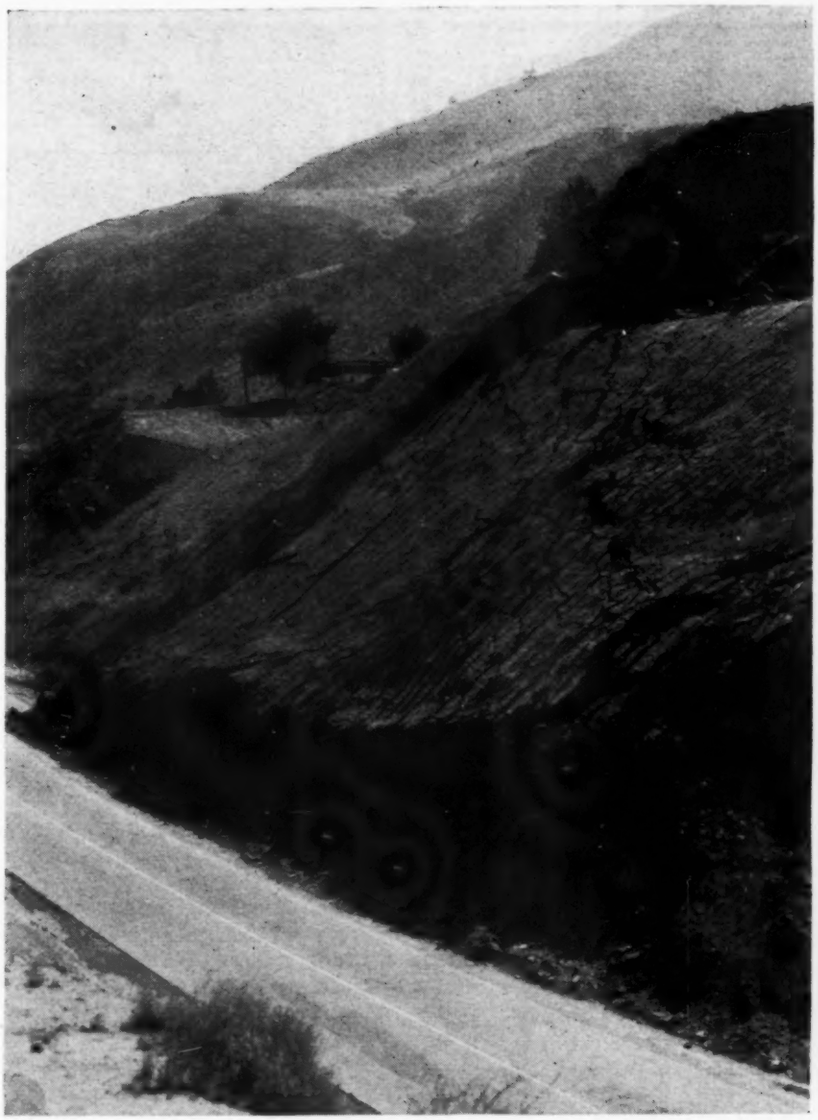


Fig. 7.—Showing a cut bank slide along the highway by the pumping plant

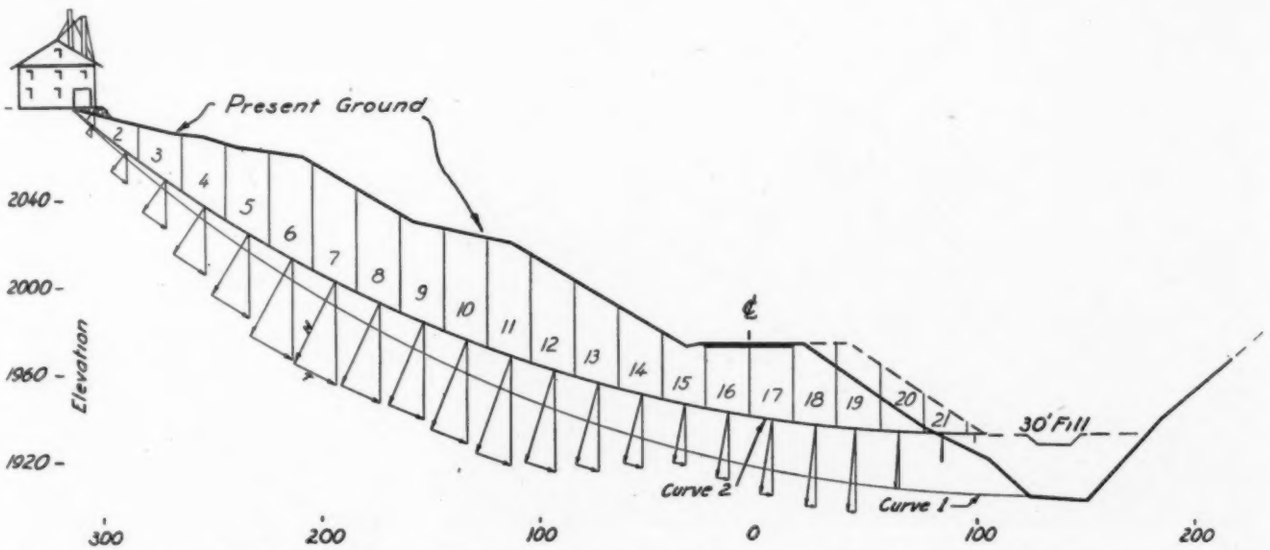


Fig. 8.—Swedish analysis applied to critical section. Curve 2 is one calculated in this article. Curve 1 is the most dangerous curve for a possible slide; the hill, however, is at rest and the existing safety factor may be much higher than 1.0

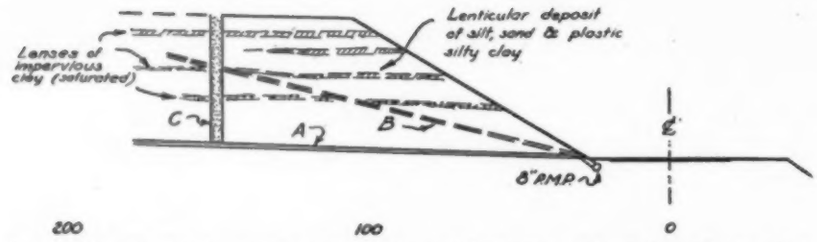


Fig. 9.—Plan showing how vertical sand drains and horizontal perforated metal pipe drains take underground water out of the highway cut banks. A—Horizontal drains 75 to 150 ft. in length to be installed on flat grades 20 to 50 ft. apart as found necessary. B—Drains to be installed on steeper grades if A-drains do not dry up ground water. C—20 to 30 vertical sand drains, 24 in. in diameter, spaced 20 to 50 ft. apart to carry water from upper seepage areas down to horizontal A-drains. All horizontal drains will be connected into 8 in. perforated metal pipe after back slopes are flattened

curve 2 data derived above, using the value of 570 lb. per sq. ft. for C as obtained for curve 1 in order to get a relative comparison with the most dangerous possible condition:

$$SF = \frac{C + N \tan \Phi}{T}$$

$$= \frac{570 + 3522 \times 0.268}{1268}$$

$$= 1.2$$

In other words, the possible slide condition can be made 20 percent safer by constructing the 30-ft. toe load as indicated on figures 5 and 8.

Comment might be made to the effect that laboratory test values for C should have been used to calculate the safety factor. But that question is readily answered by the fact that the engineers' judgment of a safe value for Φ outweighed any need for a laboratory value of C since only relative safety factors were desired.

Increasing Safety Factor

Most of the sliding ground along the highway below the pumping plant has been due to hillside seepage water which sinks into the flat back or west of the pumping station and then percolates out into the highway cut through the pervious layers of sandy material. If it is found that horizontal drains do not lower the ground water level sufficiently, this trouble will be stopped by installing vertical drains on the flat. Vertical drains will be sunk so as to connect with the strata tapped by horizontal drains. This plan is shown in figure 9. Because of the various strata of clay with water seeping between each layer, the vertical sand drains were necessary to collect the water so it could be removed by one set of horizontal pipe drains.

Reconstruction of Grapevine Grade

Reconstruction of Grapevine Grade arterial to a divided 4-lane highway presented a unique problem in soil mechanics and hydraulics. The existing 3-lane highway on the long 6 percent grade is perched 75 ft. above the bed of Grapevine Creek, on a

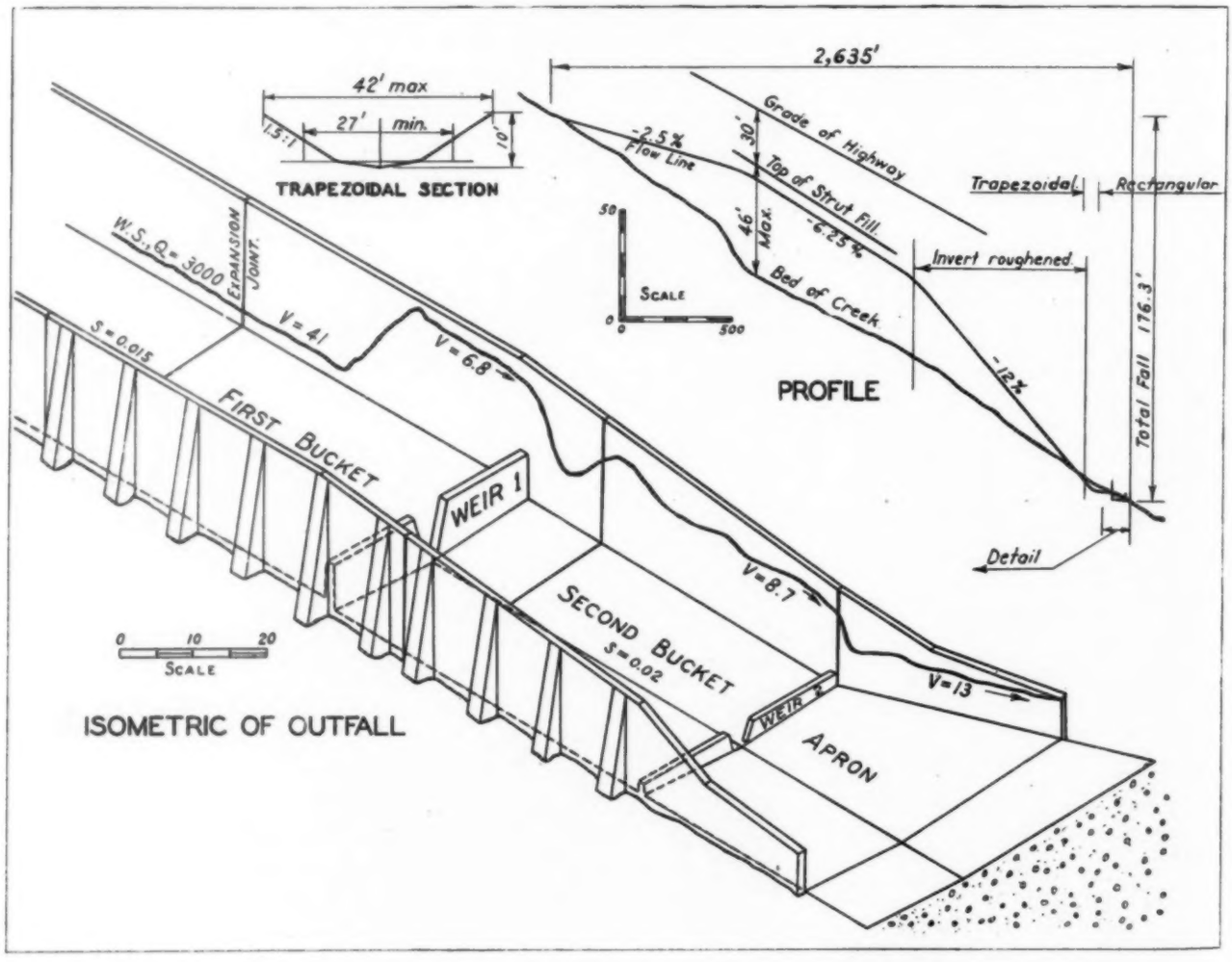


Fig. 10.—Isometric view of outfall of paved flume. Hydraulic jump employed to reduce velocity for scour prevention

Fig. 11.—Construction operations on Grapevine Grade south of the pumping plant. Existing three lane road was widened to four lanes

canyon wall which is notably unstable for one stretch of 1200 ft.

The creek drains a cloudburst-frequented area of the Tehachapi Mountains; for design, the discharge was taken at 3000 sec.-ft. The 7 percent gradient of its bed makes a respectable torrent in the narrow canyon, with a combination of high velocity, bed load of cobble and boulders and surface load of oak logs and trees.

A decision to stabilize the canyon wall by filling the creek bed with an

Fig. 12.—Grading completed ready for paving work on Fort Tejon end of Grapevine Grade

earthstrut 30 to 45 ft. high solved the problem in soil mechanics and created the one in hydraulics. The best plan, hydraulically, projected a 2065-ft., double-box culvert, protected by a debris barrier above the entrance, and with an energy-dissipating bucket outfall, all on the existing grade of the creek. Heavy design, to resist distortion after the fill was placed on the unstable bed and also to permit additions to the fill (for further widening or increased stability), was so costly that the instant and novel plan was adopted.

The strut fill was extended upstream on a 2.5 percent gradient to meet the bed of the creek. From a cut-off at this point, a trapezoidal smooth-paved channel was constructed down the 2.5 percent ramp and on a 6.25 percent gradient over the strut fill, then down a 12 percent chute 800 ft. to an energy-dissipating outfall.

Neglecting the effect of aeration and debris load, velocity at bottom of chute would have reached 50 ft. per sec. This has been reduced to a computed 41 ft. per sec. (reducing energy head by 12 ft.) by roughening the invert of the flume on a large scale. This roughening followed a herringbone pattern, with grooves 6 in. wide by 1½ in. deep on 2 ft. centers inclined at 45 degs. upstream from center line of invert. The grooves were formed by pressing beveled-edge 2-in. by 6-in. planks into partially-set concrete.

The outfall structure is a double bucket formed by two weirs across a rectangular section, followed by a concrete apron. At low stages the creek will flow through Cippoletti notches in the weirs. As the creek floods, the upper weir will induce a jump and the lower weir assures a jump at high stages by submerging the upper weir. At certain stages a jump will occur between the weirs, but this is not assured at high stages. Formation will depend upon channel control developing below the apron,

Fig. 13.—Ready for paving on extra lane of Grapevine Grade, looking toward Fort Tejon

that is, whether there is scour or deposit.

The first weir is 6 ft high, the second 2.5 ft. Computed stage and velocity for the design discharge are shown along the far wall on the isometric sketch. Both weirs are aerated to minimize cavitation.

The apron is a slab flared to the

Fig. 14.—Constructing paved flume on Grapevine Grade over 30 ft. toe load which filled the old creek bed

Fig. 15.—Outlet end of paved flume. Note corrugations constructed in bottom of flume to retard velocity. View taken opposite pumping station

left, partly protected by wingwalls. It is anticipated that the outer section will be lost or damaged frequently,—such an expendable portion being more economical than extension of the improvement to a permanent control.

The structure, exclusive of the earth fill, will cost $60,000.

Credit

This article was prepared through the cooperation of Mr. T. E. Stanton, Materials and Research Engineer, Mr. R. L. Richardson, Junior Physical Testing Engineer, and Mr. O. J. Porter, Senior Physical Testing Engineer of the California Division of Highways of which Mr. C. H. Purcell is State Highway Engineer. All photographs were furnished through the cooperation of Mr. J. W. Howe. Mr. R. R. Rowe furnished the information regarding the paved flume design. Mr. E. T. Scott is District Engineer.

The Griffith Company of Los Angeles are the contractors on the grading of the six-mile stretch through Grapevine Canyon. This work is just nearing completion.

The state is doing the Hydrauger work for installing the horizontal perforated 2-in. metal pipe.

War Construction Problems Considered By A. G. C.

The 23rd annual convention of The Associated General Contractors of America, held Feb. 16-18 at Indianapolis, Ind., was devoted primarily to the development of means for the most efficient use of all types of general contractors throughout the country in war and civilian defense construction.

Highlights of the convention, as summarized by retiring President M. W. Watson, of Topeka, Kans., were:

1. A unanimous pledge of full support of the association and its members to the war effort.

2. A demonstration of the feeling by contractors that they could be performing war construction in greater volume if the work were made available.

3. A finding that government officials in charge of construction should determine the type of contract to be used, but it was the duty of the industry to advise on contract procedures which would permit maximum use of all units of the industry.

4. The urging of continued cooperation of government officials and organized labor for the stabilization of wages and working conditions in the war program.

Official actions of the convention were taken in the resolutions. A resume of the more important resolutions follows:

"Firmly convinced that if this war is to be prosecuted to an early conclusion all private industry wherever practicable and possible should be mobilized under industrial leadership" the convention offered "the services and facilities of all its members in all localities to the national government and urges the fullest possible immediate use be made of them."

Regarding construction contracts, the convention resolved that "Those charged with the responsibility of determining government policies in matters of the type of construction contracts should be guided solely by consideration of speed in the completion of structures for the use of the combat services and of manufacturing agencies."

Concerning the "architect-engineer-manager" form of contract being adopted under certain circumstances by the Corps of Engineers, another resolution stated that whereas "completion within a comparatively short period of time and under stress definitely involves and requires the accumulated managerial experiences inherent in the general contracting business, including the ability to secure, at proper prices, materials, equipment and sub-contracts, and to efficiently assemble and coordinate labor and construction facilities when and where required" the convention recommended that "in the event that government departments should elect to use the so-called A.E.M. type of contract on some particular projects, the government departments should be advised of the advantages to them of insisting that a qualified general contractor be a prime party to the A.E.M. contract, and that as such the general contractor be charged with the management of the entire construction operation in the field."

Observing that the OPM-AFL Construction Trades Stabilization Agreement had been in effect on the majority of defense work for six months during which time the industry had made "a remarkable record of uninterrupted work during war conditions" the convention resolved that "the building and construction trades department of the A. F. of L., the labor division of the War Production Board, the War and Navy Departments, the Federal Works Agency, the Maritime Commission and the Defense Plant Corporation be commended for their increasingly successful efforts to avoid work stoppage caused by disputes and to stabilize wages and hours of employment on those defense construction projects employing AFL workmen and administered by those agencies" and resolved that the agencies and labor organizations "be urged to continue their efforts to accomplish further adjustments and stabilization of labor policies to meet the construction requirements which develop as the war effort increases; and that the Labor Relations Committee and the national staff of the association continue to cooperate with the stabilization effort."

Illinois Gas Tax Revenues Increase.—Gasoline tax revenues in Illinois for January, 1942, totaled $3,430,829, an increase of $140,000 over January, 1941, according to George B. McKibbin, Finance Director of Illinois.

Eastern Panama Explored for Possible Highway Route

By PROF. RICHARD TEWKESBURY
Charlotte, North Carolina

WITHOUT a road between Panama City and the Colombian border a long detour would be necessary, possibly by water to La Guaira, Venezuela, and then to Bogota, involving days of delay and over two thousand miles of additional travel, if one were to start driving from the United States to South America.

I am one, who has caught the vision and the spirit of freedom of travel between the New World republics. There are hundreds of thousands of enthusiasts like me in this New World. We are all potential travelers of the great Pan-American highway system. We are all waiting until the Central American sections are completed.

To see if I could help to hasten the day, in 1938 I prepared to enter the Darien region, going first to Panama City and there make a survey of what I might encounter. The following year I again appeared in Panama and was ready for whatever was to lie ahead of me. But it was not for me to get through that year. I had much to learn and many adjustments to make before it was possible to overcome all the obstacles.

Again, in the summer of 1940 I appeared on the banks of the Bayano River just outside of the town of Chepo east of Panama City. My equipment was reduced to a minimum, carrying only a jacket and sleeping bag to shield me from the elements, some canned food, and a machete to be used in a multitude of ways in getting food, making a shelter, or serving in its characteristic way for protection. And why did I not carry a gun? What chance has an inexperienced white man against a group of two hundred curious Indians? I'll rely on a smile any day.

Many stories were told to me by generally reliable people about what I would find in the region — Indians that would kill me, Indians that would drive me from their villages, gold, ancient ruins, and species of beasts not yet found in the New World. I will say that along my path I found none of these things. You can easily see that my greatest difficulty was coping with fear. How often we have been told that we have nothing to fear except fear itself.

I felt my work was to go into the region and do three simple things: 1. Record the general topography, 2. Bring out samples for technical experts, and 3. Learn the attitude of those dwelling there. I entered the territory determined to meet the Indians as an equal. I was a guest, not invited, rather thrust upon them. I would be respectful, and in return demand respect. Only once did I lose that status. It resulted in the Indians leading me off toward the coast and leaving me in the jungle to find my way the best that I could.

Starting the Trip

When I first entered the jungle, the Indians poled me in their dugout boats up the Bayano River for three days until we came to a village. It was there that I met the first chief. His actions revealed that he was not at all certain I was wanted in his territory. Fortunately, the Indians know the value of the dollar and with it marvels can be accomplished. After a lengthy conference and after demonstrating by my actions among them that I was merely a tourist interested in seeking knowledge on a friendly basis, I was permitted to remain with them. Eventually, arrangements were made for two Indians to take me on farther up the Bayano River.

Construction of a Telford base road on a hacienda. All work done by hand with local labor

During the next four days those two Indians labored from before daylight until evening to pole our small boat up the ever steeper Bayano River and deeper into the heart of Darien. Struggling together against the torrential rains and dazzling sun and fighting for food made us mutual friends, although we spoke no common language and were of an entirely different race and mode of living.

In this section the river cuts through low sharp hills completely covered with thick, nearly impenetrable vegetation. The narrow ravines are rich and support an abundance of vegetation. None of the region is under cultivation for no Indians appear to live there. Their villages are far apart and their numbers are small. I am led to believe that not more than a total of two thousand Indians live in the upper interior along the Bayano and Chucunaque rivers.

At the end of reasonable navigation the Indians have established themselves in one of their larger villages. Surrounding, are many small clearings where they raise corn, cacao, and plantains of mediocre quality. Life is simple in the villages and agricultural methods are likewise crude, the only instrument for cultivation being the machete. Guns of a 1907 model are used for hunting birds and mammals, while the bow and arrow is commonly used for getting fish.

The surrounding hills are steep, although they are not high. Soil is thin on most of the hills, yet it is amazingly rich. Rock ledges crop out to the surface, frequently. Strata often cut directly across the Bayano River and bury themselves in the hills opposite.

Possible Highway Routes

From all indications the topography of the region of the headwaters of the two rivers is much smoother than in the lower valleys of each stream. Twice my route has taken me along

Typical of the terrain where road would be constructed

the main Caribbean cordillera, for I do not believe it wise, nor perhaps possible, for a lone traveler to trudge blindly onward for days, guided only by the use of the compass and unable to orient himself from time to time. The cordillera, which was my route, is mainly made up of sharp hills, is entirely jungle covered, is void of Indians, and is a region devastated with rainfall, exceeded by only a few other regions in the Western Hemisphere. This should and will be taken into account when a highway is routed. Physically, there are no obstructions which would prohibit the building of a skyline highway. However, in the four months of the rainy season, it might turn out to be more like a subterranean sea route.

You are probably speculating, what then is a feasible route? In fact, there are several, and each has its advantages and its unfavorable characteristics. A route could be laid out along the Pacific coast following in general an elevation of a hundred feet. This route would require the installation of a ferry system across the San Miguel Bay. Here one would be faced with the problem of the "efficiency loss" when ferrying is necessary.

An alternative route could be along the Caribbean coast, not a shore line road, but inland possibly two miles, along a low rough piedmont. This route would be the longest. In its favor it would offer a continuous paralleling of the coast along a reasonably healthful region free of swamps and large rivers. Being at the foot of the cordillera the rainfall would be less. Also, the Indian problem is practically solved along the coast, for the San Blas Indians have already met civilization and are commercially adjusting themselves.

The grand chief, Nele de Cantule, looks with interest toward a great highway some day running from Panama City toward his village of Portogandi and then on along the coast to Colombia. I have only the friendliest relations with him to report. And from the amazingly intelligent questions his interpreter asked me, I am led to believe that Chief Nele can be relied upon to aid in smoothing out any difficulties with Indian rights along the coast or even inland as far as the valleys of the Bayano and Chucunaque rivers.

And, of course, the other feasible route would lie inside those valleys between the main rivers and the cordillera. This would open entirely new country, would be a most healthful route for all to travel, and perhaps the most direct route paralleling the Tuyra River and straight to the Atrato River in Colombia. Two objections would be, the slightly rough terrain and the slightly more acute Indian problem.

We shall follow out this latter route, for it is more nearly that of my trip. I spent a total of ten days on the cordillera, tramping while fighting the elements. With an elevation averaging approximately two thousand feet the top of low hills form a backbone of stone, covered with a thin layer of loam which supports a medium dense jungle. Along this ridge storms continually break, lightning cracks, thunder rumbles across practically the whole of Darien, and torrents of water gush and fall down the sharp ravines. In my report, more often than anything else, I have recorded, "rain on the ranges."

Directly south of Pinos Island, recognized easily as being geologically a "drowned mountain," it was necessary to make the decision of turning inland from the summit of the cordillera. Inland somewhere a chance hike would lead me to the Chucunaque River. It is not such a chance geographically as it is a chance mentally, for each step that is taken easily down hill in the direction of the Chucunaque River, means that mentally you are trapping yourself step by step deeper in the heart of Darien; and if the river is not found, escape to the coast is doubly difficult. Here again I stress the fact that we have nothing to fear except fear itself. Nothing prevented the descent, down the middle of small streams, into the valley of the Chucunaque, but when I arrived among the few Indians that dwell along the Chiati tributary, I was mentally exhausted to the extent that it impaired my physical strength.

Those Indians, few in number, resemble those of the San Blas coast and their attitude indicated they have commercial intercourse with the San Blas coast, thus being under the jurisdiction of Chief Nele.

Away from the dense jungle this terrain affords easier place for road

Proceeding Eastward

The Chucunaque River, in all respects, is an older stream than the Bayano River, though frequently it appeared identical. The flood stages of twenty feet or more were observed on both streams. In their upper regions similar strata protrude, but in the lower region the Chucunaque River takes on a quieter and more majestic flow, not having to force itself through a low mountainous area as the Bayano River must.

The low ranges recede on either side, leaving the wide valley of the Chucunaque River so fertile, yet apparently so very void of human habitation. If a highway were to be routed along the valley between the river and the cordillera, engineers would not encounter the multitudes of low sharp hills that they would along the Bayano River, a hundred miles closer to Panama City.

With the aid of two Indians we slowly worked our way, in a dug-out canoe, down the Chucunaque River to the Panamanian village of Yavisa. To me, reaching that village meant success. From there the trail up the Tuyra River by way of Paya and on into Colombia is well-known and traveled. It was at Yavisa that I purchased a common American soft drink and some bread. With them in hand I went out on the steps of the Chinese store and drank a toast to the completion of the Pan American Highway. The vision of that great road had led me on and on. Reluctantly the jungle had given up its secrets. And what were those secrets? They were two; first, there appear to be no physical barriers for modern road construction in Darien, and second, there is an Indian problem which can be solved if handled properly. They love their secluded homes, yet they know and love the value of the dollar. I tried to leave with those Indians the impression that the white man always has gotten what he wanted; so, when it comes time for the highway to be routed, all

the chiefs should get together and make the most equitable bargain with that white man.

Along the Tuyra River, reaching back into the hill country towards the Colombian border, Indians would offer no serious problem, for the commerce of the world has changed them, both those on the lower river and even those of the Paya group. South of Paya the range is higher, yet the passes seem to offer no more resistance to road construction than those encountered elsewhere. The fact that a divide is being crossed does not mean difficulty in large mountains, for in that region the passes do not rise very high from the surrounding general level. And from that region the slope is gradual, until once again at sea level, the great Atrato River in Colombia is reached.

Over the route I traveled I found no major obstacles, such as deep canyons, rivers requiring extensive bridging, except for the crossing of the Atrato River, nor swamps necessitating wide detours. Those of us who have encircled this world have no doubt in our minds that by modern means of construction a road can be routed through Darien. We can just compare it with tropical regions elsewhere that have been conquered with roads—such as those built through the swamps of Louisiana, the Overseas Highway in Florida, roads in the Philippines, the Malay Peninsula, and the Wang Tung province in China.

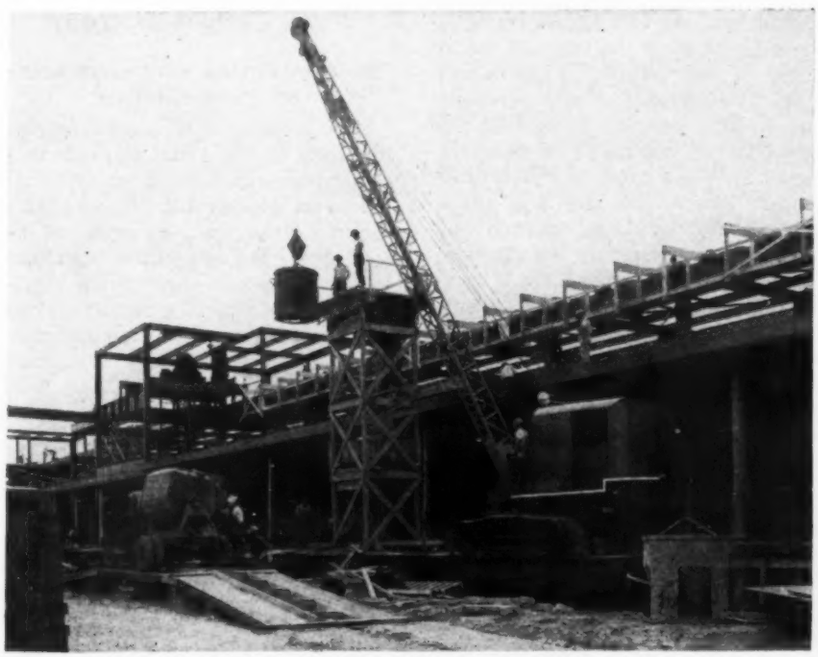
The Pan-American highway will open for us a new era, the like of which this hemisphere has never experienced, when the first automobile travels from Buenos Aires or Rio de Janeiro to Chicago, Winnipeg, Quebec, or Vancouver, B. C.

Crane and Tower on Flatcar Expedite Pouring Concrete

An interesting set-up is used by Fruco Construction Co. at the St. Louis Ordnance Plant, St. Louis, Mo. A heavy-duty ¾-yd. Bay City diesel crane and a 45-ft. tower are mounted on a 50-ft. flatcar as a combination for delivering concrete from a truck mixer to elevated bin. Bin is equipped with two chutes—one for the first floor and one for the second—making it possible to pour at two floor levels without moving equipment or changing chutes. Concrete is handled in a 1-cu. yd. concrete bucket on single line. At time photo was taken, approximate average daily pour totalled 540 yd. in 9 hour shift.

Building is 1200 ft. long and flatcar is moved from one setting to another by using a dragline cable on the front drum of the crane. Cable is anchored by a hook to the rail or tie. Thus the complete unit can be moved the exact distance required in either direction. When necessary, ramp for truck mixer is moved by the crane to new location. However, the big capacity of the crane and the use of a 50-ft. boom makes it possible to reach out at a long radius to pick up the concrete bucket for discharging into bin.

This method has proved to be very satisfactory, giving high performance and permitting bigger yardage of concrete to be poured at lower cost and in shorter time.



Crane and Concreting Tower Mounted on Flat Car

Bridge Design Competition Awards

Undergraduates of Iowa State College, Ames, Ia., made a clean sweep of the prizes in the Annual Students Bridge Design Competition of the American Institute of Steel Construction. Not only did they secure the first three prizes but they also obtained all the key certificates of mention.

The problem for this year's competition was a steel highway bridge to carry a highway over a river crossing.

The prizes were awarded as follows:

First Prize—$200—Everett Thorbrogger, Iowa State College
Second Prize—$100—R. Kenneth Kendall, Iowa State College
Third Prize—$50—Carlton Mueller, Iowa State College

A certificate of first mention was awarded to Gordon Johnson, Iowa State College, and a certificate of second mention to Wayne A. Norman, Iowa State College. Certificates of honorable mention were awarded to Dick Utterback and Ralph A. Krass, both of Iowa State College.

These awards were made by a Jury of nationally-known architects and engineers consisting of Mr. Lorimer Rich and Mr. Don E. Hatch, Architects, Mr. Henry C. Tammen of Howard, Needles, Tammen & Bergendoff, Consulting Engineers; Mr. Roger W. Sherman, Managing Editor of Architectural Record, all of New York City; and Mr. L. G. Sumner, Engineer of Bridges and Structures, Connecticut State Highway Department, Hartford, Connecticut.

Fifty-nine students from fifteen colleges participated in the competition, as follows:

Iowa State College
Virginia Polytechnic Institute
University of Pennsylvania
University of Colorado
University of Maine
Carnegie Institute of Technology
Case School of Applied Science
University of Nevada
Illinois Institute of Technology
Polytechnic Institute of Brooklyn
University of Syracuse
Cornell University
Alabama Polytechnic Institute
University of Illinois
New York University

Soil Mechanics Applied to Soil Drainage

By JOHN D. WATSON

Assistant Professor of Civil Engineering,
Duke University

FROM the earliest times farmers and engineers have been confronted with problems of drainage. When the ground isn't too dry, it is often too wet; and always, somewhere, somebody wants to get rid of this excess water.

Ditches, or underground drains, usually provide a satisfactory solution; but frequently after a considerable expenditure of time and money, the hoped-for solution is a failure. Even when the best pipe obtainable is installed and the ditches are backfilled with clean gravel, no water drains out, the wet condition of the ground continues, and the whole investment is a total loss. The fault is obviously with the soil, and not with the drainage system. This question then arises: how might this impermeable soil have been discovered with a simple test before the drainage system was installed? Such a test will be described in this article.

About ten years ago engineers with special knowledge in the field of soil mechanics began to study problems in the design and construction of earth dams. Previous to that time earth dams were not designed. The dimensions of a successful earth dam already completed were applied to the plans for a proposed new earth dam. The only consideration which the soil itself received was a provision in the specifications that certain limiting sizes of grains must be used for various sections of the dam. The fact that the greater part of the earth in the dam would be saturated, and that water would continuously seep from the reservoir through the dam was recognized without any knowledge of what could be done about it. The idea of a non-homogeneous section, that is, an impervious core in the center supported by pervious sections upstream and downstream from the center, had, however, been developed. But the idea of measuring the permeability of the soils to go in these sections, and of fixing the dimensions of these sections in accordance with the permeability measurements, was at that time unheard of by most engineers.

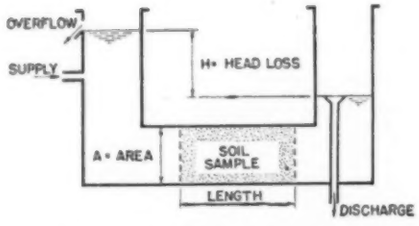


Fig. 1.—Darcy's Permeability Test

Porosity and Permeability

Every soil is both porous and permeable. But while one soil is rarely ever more than twice as porous as another soil, it is not at all unusual to find a soil that is a million times as permeable as another. A clear understanding of the meaning of these two terms is essential to an understanding of why one soil will drain readily, and why another soil will hold water for a seemingly interminable time. The void space between the grains of a soil constitute pores, which may be filled with water, air, or other fluid; and the porosity of a soil is defined as the percentage of the void volume in terms of the volume of the whole mass. The porosity of soils generally has a value between 25 and 50 per cent. To be permeable, however, means "to allow passage, especially of fluids." Hence, the size and shape of the pore openings between the grains of a soil mass are the principal factors affecting permeability. If these pore openings are large, as in a uniform coarse sand, the movement of water through such a soil would be rapid. But if the pore openings are microscopic in size, the movement of water through this type of soil would be almost, but never, immeasurably slow. A determination of the size and shape of the pore openings in a soil mass would be exceedingly difficult, and valueless in itself. But an approximate determination of the velocity with which water would move through a given soil mass can be easily made, and this result, modified by practical experience, will furnish an excellent criterion for determining whether underground drainage in this particular soil would be effective.

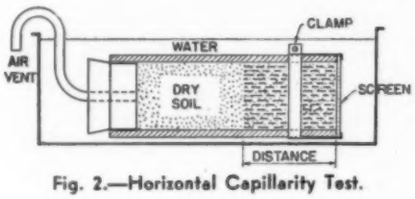


Fig. 2.—Horizontal Capillarity Test.

Darcy Law

Nearly a hundred years ago a French physicist, Darcy, measured the velocity of water flowing through soils. He found that this velocity always equalled the hydraulic gradient multiplied by a factor which he called the coefficient of permeability. Stated algebraically this law of Darcy said:

$$v = k\,i$$

of $$q = k\,i\,A$$

where q = rate of flow
v = velocity
k = coefficient of permeability
i = hydraulic gradient, or head loss divided by distance
A = area of flow channel

Determination of Coefficient of Permeability

Such a set-up as is shown diagrammatically in Fig. 1 can be made in a soils laboratory. With direct measurements on the quantity of water flowing in a given time, the length of the soil sample, the area of the flow channel, and the loss of head, the coefficient of permeability for any given soil can be computed by simple arithmetic. Many tests of this sort, combined with experience in the field, have shown that any soil having a coefficient of permeability in excess of 1.0×10^{-4} cm. per sec. is a free draining soil. Those soils which have a coefficient of permeability less than this value drain poorly, and because of this low permeability they are suitable materials for the core of an earth dam. When the coefficient of permeability is less than 1.0×10^{-6} cm. per sec. the soil is impermeable for all

practical purposes. Very fine-grained inorganic silts and lean clays have permeabilities in this lower range, while very plastic clays will have a coefficient of permeability as low as 5.0×10^{-9} cm. per sec.

This determination of the coefficient of permeability cannot be made without special laboratory equipment, and it should not be undertaken except by an experienced laboratory technician. Even then the test is apt to be slow and tedious, unless the influent head is high and the length of the sample is short. Disturbing factors in the test, not recognized by an inexperienced technician, might vitiate whatever results were obtained.

The Horizontal Capillarity Test

When confronted with the necessity of devising a quick test which could be applied in the field for choosing between pervious and impervious materials for an earth dam, Professor Arthur Casagrande of Harvard University developed the horizontal capillarity test. This test is simplicity itself, and it can be performed with a minimum of special equipment. It consists of immersing an open-ended tube of dry soil horizontally in a pan of water, and measuring the rate at which the soil is wetted by capillary moisture, as shown in Figure 2. The open-ended tube must be transparent, with one end covered by a screen but otherwise open to the water, while the other end must be tightly sealed to the water but open to the atmosphere. Thick-walled glass tubes about 2 inches in diameter are satisfactory, but a tube of 'hicite," a transparent plastic made by duPont, is preferable because it does not break easily.

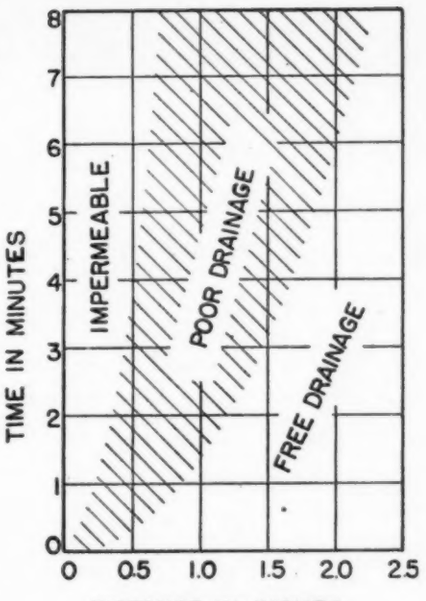


Fig. 3.

Simple Method of Interpreting Test Results

The soil should be oven dried. Naturally, it should not be baked like a brick. And it must be pulverized, so that the individualized grains are separated, but not crushed. Pack the soil into the tube, so that the sample has a density as nearly equal to the density in the ground as possible. Immerse the tube horizontally into a shallow pan of water, and note the time. Rotate the tube so that the water advances uniformly through the tube. Make several observations of the distance in inches and the time in minutes. Then a reference to Fig. 3 with these results will indicate whether or not the soil will drain freely or poorly. This answer must necessarily be based upon the assumption that the soil in the ground is as homogeneous as the soil in the test tube. Fissures in the ground, roots, gravel pockets, and the holes of burrowing animals may make the natural ground more permeable than the test would indicate.

Since this test is primarily a quick test for use in the field, the results are qualitative rather than quantitative. However, by correlating the results of the horizontal capillarity tests on soils from a given area with laboratory tests for the actual determination of the coefficient of permeability, it is possible to secure from the horizontal capillarity test quantitative results which are very close approximations to the true values. For details on this determination see "Notes on Soil Testing for Engineering Purposes" by A. Casagrande and R. E. Fadum, privately printed by the Graduate School of Engineering of Harvard University.

Missouri Highway Engineers' Association Holds 35th Annual Meeting

The Highway Engineers' Association of Missouri held its 35th annual convention in Kansas City, February 18-19-20, 1942, at which some of the outstanding engineers and road builders of the state and nation participated.

The following officers were elected:

President: P. H. Daniells (Engineer of Surveys and Plans, Mo. State Highway Department), Jefferson City, Mo.

Vice-Presidents: J. H. Thompson (Jackson County highway engineer), Kansas City, Mo.; L. W. Fitzpatrick (WPA engineer), Rolla, Mo.; E. M. Basye (assistant state WPA director and a former railroad engineer), Jefferson City, Mo.

Secretary-Treasurer: J. J. Corbett (Engineer of Construction, Mo. Highway Department), Jefferson City, Mo.

Featured speakers included Carl W. Brown, chief engineer of the Missouri State Highway Department; Brig. Gen. U. S. Grant III, commander engineer and replacement center, Fort Leonard Wood, Mo.; Lt. Col. H. A. Montgomery, Corps of engineers, U. S. Army, of Tulsa, Oklahoma; Lou Holland of Kansas City, mid-central war resources board; Hugh Stephens, Jefferson City, Mo., administrator State Council of Defense; Wardner G. Scott, Nebraska state highway engineer, Lincoln, Nebraska; H. K. Bishop, chief, division construction, U. S. Public Roads Administration, Washington, D. C.; Ben H. Petty, professor, highway engineering, Purdue University, Lafayette, Indiana; John W. Poulter, research engineer, Milwaukee, Wisconsin; C. C. Wiley, professor civil engineering, University of Illinois at Champaign; Chas. M. Lancaster, soils engineer, Missouri Highway Department, and others of state and national prominence of various phases of highway work.

Next year's convention will be held in St. Louis, Mo.

New List of Standards Available

The American Standards Association has announced the publication of its new list of American Standards for 1942. In view of the importance of standards and specifications, not only for every day work but to speed up production for defense, this particular list of standards should be in the hands of the engineering and purchasing departments of every manufacturing firm in the U. S.

Nearly 500 American Standards are listed in a wide variety of industrial fields and in the fields of industrial and public safety. There is a separate heading for American Defense Emergency Standards — standards developed specifically for defense purposes, and for the first time all American Safety Standards are listed together in a separate section.

This list of American Standards for 1942 will be sent free of charge. Requests should be addressed to the American Standards Association, 29 West 39th Street, New York, N. Y.

Economic Factors Involved In Proposed Highway Construction—

By W. L. ANDERSON
Design Engineer, Utah State Road Commission

TWO viewpoints on "Economic Project Comparisons" might be taken in any discussion of the subject: (1) A study of road construction or reconstruction as made by a public body operating a system of roads; and (2) a study of projects that might be constructed and paid for by revenues derived from users of these roads, such as a toll road or a toll bridge.

The writer took the view-point of the public body in this article which was a discussion he presented before the Third Annual Highway Engineering Conference of the University of Utah, and did not attempt to analyze a self-liquidating project.

The three basic elements in an economic study of highway projects are: (1) The cost of the project; (2) the income or revenue available to finance the project; and (3) the benefits to be derived after the project is completed.

The public body is limited by definite appropriations as to income and revenue available. This item will, therefore, indirectly affect the item of the cost of the project by influencing the standards of design.

Under the item of benefits to be derived after the project is completed, a division of these benefits into two parts might be made: (1) "User Benefits," and (2) "General Benefits."

Improvement Benefits

Under the user benefits might be listed the savings in time, savings in operating costs, and decrease in accident costs. Decrease in operating costs can easily be computed if the new highway shortens the length of the existing road, reduces grade, or eliminates stops. However, this reduction in operating cost is partially offset by higher fuel cost per mile due to increased speeds. The saving in time is probably of greater importance than a possible saving in operating costs, although difficult to evaluate. The development of the transportation system from earliest primitive days to the modern high-speed airplane has had as a main objective the saving in time. Unfortunately, there has been some confusion in attempting to evaluate time saving. Arguments have been put forth that if a person saves ten minutes in traveling a road, he only wastes it in talking to some one. This confusion is failure to differentiate between the desire to save time and the purpose for which the time was saved. *If the motorist is willing to pay for time saving, whether it is saved for business or recreation should be of no concern.*

Time saving also has an economic value. The time required for freight movements greatly affects the profits which might be derived. A study of roads used by truck traffic in this state, such as the road between Brigham City and Logan via U. S. 91 and U. S. 89, shows that nearly 80 percent of the truck traffic travels over U. S. 89. The length of U. S. 89 is 35.3 miles, compared with 25.9 miles on U. S. 91. However, U. S. 89, having a 920 foot lower summit elevation, is a faster road for truck traffic and, therefore, used by such traffic. On the other hand, touring cars which do not require the shifting of gears on the grades encountered on U. S. 91 take the shorter road.

Reduction of accident costs should be given most serious consideration in the selection of a project. The loss of life and property due to automobile accidents each year is tremendous in this nation. It is, therefore, necessary that a very careful survey be given as to the location and cause of accidents. At such locations that show a concentration of accidents, after a careful analysis of the cause, reconstruction of these sections of highways are justified, even though no other benefits are to be derived.

Reduction of accidents by *education and enforcement is not the solution*, but only by proper engineering can satisfactory results be obtained. The purpose of a highway is mobility; enforcement generally retards mobility. Education is limited to the response of the operator. Education and enforcement, of course, are necessary but not a solution to the accident problem.

Other benefits that result from the construction of a highway are general benefits which include national, state, community, and land service. The general benefits involve improved facilities for national defense, which is of the greatest importance and especially emphasized at the present time. The general living conditions and cost of living of entire sections of the state, especially those sections that might be isolated from any other form of transportation, will be greatly affected by the construction of a highway. Improved transportation facilities will reduce the cost of goods brought in to such localities for consumption and bring greater returns due to cheaper transportation costs of goods produced within the locality. Other general benefits might include recreation, education, and improved police, fire, and health protection.

Improvement of rural roads has permitted the centralization of schools by transporting the pupils to better equipped schools at a lower cost to the public.

A considerable portion of the users of a highway system is made up of recreational traffic. Though such traffic might not be given as high a preference rating as commercial traffic in considering the necessity for a project, such traffic, in normal times, is essential to the life of the nation; and projects to permit such traffic to visit nature's wonderlands are certainly worthy of serious consideration. Indirectly, such recreational roads greatly affect the economic life of communities near such areas and, to some extent, to the nation as a whole. General benefits are difficult to evaluate; however, from an economic standpoint they are probably of far greater importance than user benefits.

Many roads are not self-liquidating; that is, the direct revenue obtained from the users of the high-

way is not equal to the cost of constructing and maintaining such a road. However, these roads may be entirely justified due to the general benefit to the local area, state, and nation. Such roads, of course, must be financed by revenue obtained from earnings derived from other better-paying highways or by other forms of taxation.

Project Selection

In the operation of a public road system, maintenance costs should be given very careful consideration in the selection of projects for reconstruction. As the total revenue for maintenance and construction is generally limited to a definite sum, reconstruction of those sections of road where maintenance costs are high will naturally provide more funds for construction.

Consideration must also be given to the elimination of any weak part of the highway system, such as a bridge that is limited in loading capacity or a section of highway that has inadequate surface stability to carry surface loading, inasmuch as such weak links in a roadway will limit the loads that might be carried over the entire highway and result in a higher transportation cost.

I know of no formula which might take into consideration the various user benefits and general benefits by assigning an exact mathematical rating to each of them and obtaining a priority to improvement of projects. From the mass of data which has been accumulated by the planning survey, by technical studies, and other means, ratings have been developed for some of the factors; yet the very factors to which it is impossible to assign a rating are often those which, in the final analysis, govern the selection of the project.

Ratings of priority should be assigned to those factors for which such ratings can be clearly determined.

Priority of project improvement might be made under each of the following factors:

- Widening of narrow two-lane roads to wider two-lane roads;
- Widening of two-lane roads to four-lane roads;
- Reconstruction of weak bridges and surfaces;
- Reduction of maintenance costs;
- Reduction of accident costs;
- Time loss, due to reduced speeds, caused by poor alignment, short sight distances, excessive grades, and restricted speed zones, especially in towns;
- Economic saving by reduced distances, reduced grades, etc.

Other factors might also be rated: however, there are many important remaining factors which must be judged by experience, common sense, and policy, as must, also, the relative importance of all the factors.

Fund Influence On Design

After a project has been selected for construction, there are many economic factors entering into the design of such a project. The one factor that has influenced the standards of design more than anything else is the limited total funds available for highway construction. During the early days of highway development, the engineer was faced with the task of constructing a large mileage of unimproved roads. The plea was to "get the automobile out of the mud." Many justifiable and economic factors had to be overlooked, and the design of the highway cheapened to the maximum in order to get greater mileage; that is, it was considered far better to have ten miles of all-weather passable road on inferior grade and line, than one mile of super-highway and nine miles of impassable road.

With the increase of traffic, dust conditions became intolerable on the road and the engineer was again faced with the decision of sacrificing quality for quantity. Dustless road surfaces were developed that were relatively cheap to build and thereby large mileages could thus be treated. However, many such highways have been costly to maintain, and if funds had been available, a higher type surfacing would have proved far more economical.

The public highways of the nation are now undergoing another reconstruction period, and the engineer is still faced with the same problem of balancing quantity against quality. Due to reduced appropriations that have been available for highway construction, the engineer has been required to adopt designs that are not of the best type in order to improve a greater mileage.

The modern freeway or a roadway which is reserved exclusively for vehicular traffic, which has no direct access to abutting property, eliminating stopping and parking, which has no cross traffic but grade separations, which has medial dividers for opposing streams of traffic, and high standards of alignment, grade, pavement surfaces, and other desirable features is the ideal and, in many cases, the economical road. But such roads are very expensive, so without increased sources of funds, their construction will be very limited. To provide such funds would result in a big economic saving over a period of time.

In the design of the project, the proper location of the highway and the obtaining of adequate right of way are the most important factors, because if the location is wrong, the entire investment must be sacrificed in order to make a correction. Surfaces can be strengthened or roads widened with very little loss of the original construction cost; therefore, if a sacrifice in the design must be made, the construction of the temporary, cheaper surface, or narrower roadways would be preferable to a sacrifice in the standards of alignment or grade. Features which enter into the safe operation of the highway should be given full consideration in order that high accident costs will not result in the construction.

Design Factors

Just what assumed design speed should be used in the design of the highway is questionable. As previously stated, the saving of time, although difficult to evaluate, is a prime factor to the user of the highway. Speeds of 75 to 100 miles an hour are not uncommon on some of our western highways of modern design. To design for a speed of 100 miles an hour requires long radius curves, preferably a maximum of 2 degrees. Superelevation for such speeds cannot be provided on sharper radius curves without exceeding the maximum generally conceded as permissible, which is 8 per cent to 10 per cent transverse slope, the lower figure being adopted in areas where snow and ice conditions are severe. Such standards of curvature, of course, are not economically feasible in all sections of the country. In mountainous roads it is necessary to adopt a lower design speed. It is preferable that the design of the highway be consistent with the speed adopted for the particular mountain road; that is, curves of approximately the same radius are preferable rather than a long radius curve followed by a sharp curve, as such conditions increase the accident rate.

The traffic volume, of course, should greatly influence the standards. However, the engineer must keep in mind that he can only design for the lower speed by incorporating into the design, features which prohibit fast travel such as poor alignment, poor surfaces or enforced restricted speed zones through populated areas.

He cannot design a narrow surface, with short sight distances for thirty miles an hour, if the alignment is of 100-mile an hour standard. The human factor to travel the road at the

higher speed will govern and the low standards of width of roadway, sight distance, etc. will only be conducive to accidents. In other words, the design must be adequate to care for the traffic with a reasonable degree of safety at the speed the user will select—*not what the engineer desires as a maximum speed.*

Design Speed. — Just how much money might be spent to increase the design speed through a canyon section or other localities where the cost is proportionately high is difficult to determine; actually, the operating cost of the vehicle will be less on the lower speed roads due to a decrease in fuel consumption, tire wear, etc. However, as previously stated, the saving in time, both for commercial and pleasure vehicles, is of considerable economic importance. Assuming a road 10 miles long has a traffic volume of 1,000 vehicles per day, the difference in traveling this road 40 miles per hour and 60 miles per hour would be 5 minutes. This would result in a total saving of 5,000 minutes per day, or approximately 30,000 hours per year. The value of this time would vary greatly between the different vehicles, but the value of the driver's time, passenger's time, and rental values on vehicles must be considered, besides other general benefits. This is difficult to determine, but an assumption of $1.00 per hour does not appear to be excessive. This would equal a time saving of $3,000 per year per mile of road by increasing the speed from 40 to 60 miles per hour. If capitalized at 5 per cent, this would equal $60,000, which, if the assumptions are correct, might economically be spent per mile, *extra*, to obtain the higher design speed. This is only an example. Research is necessary to verify the exact value of time, to show that time saving does justify considerable additional expense in construction.

By-Pass.—In the design for saving of time, elimination of restricted speed zones is of prime importance. This involves the by-passing of towns and cities and also requires adequate roads through cities. Examples of stretches of modern super-highways approaching some of our large cities only to be met at the city limits with a congested 10-mile-an-hour road are voluminous. Opposition to by-passing in many localities is very strong and, for an organization regulated by a political administration, it is difficult to overcome. In by-passing a town it is true that some suffer, but the benefits and savings resulting from the by-pass are manifold. Careful compilation of facts and educational programs are, therefore, essential. As part of the by-pass, adequate roads through the towns with proper connections should be a part of the highway plan.

Location.—In locating the project it is, of course, desirable to obtain the shortest, feasible route. The shortening of a project from an operating standpoint, alone, will justify a considerably increased construction cost, which will also show a continuous reduction in maintenance and operating costs. Assuming an average operating cost per vehicle of 5 cents per mile, a highway carrying a thousand cars a day would save $50 per day per mile of decreased distance, or a total of over $18,000 per year, which, capitalized at 5 per cent, would equal $360,000. This annual saving to the highway users would, therefore, justify a much greater increased cost in the construction of the project in order to shorten the road.

Grades.—In the consideration of maximum grades to be used in the design of the project, the general type of the country will greatly influence the grade selected. In a mountainous country where frequent stretches of maximum grade are encountered, the benefit derived from reducing one stretch of such grade to a grade lower than the maximum is not as great as in a locality where maximum grades are not encountered over a long portion of the highway, as the truck load will be limited to the maximum grade encountered. On the main highways in Utah, a maximum grade of 6 per cent is used except in a few extreme conditions where the cost of obtaining this lower grade is practically prohibitive. A study has been made as to the effect of snow and ice conditions in Utah, and it has been found that very little trouble is encountered in obtaining traction on grades of 5 per cent and under; however, considerable difficulty is encountered on grades of over 5 per cent. A considerably increased expenditure in areas subjected to snow and ice conditions is justified in reducing grades below 5 per cent; however, in mountainous country this is not always practicable.

In the cost of operating a car on the higher grades, very little saving in operating costs is effected as to passenger cars by reduction of grades under 6 per cent. The cost of operating trucks increases considerably on grades of over 3 per cent.

It is noted in the Oregon State Highway Commission Technical Bulletin No. 5 that tests conducted by that department show an increase in fuel consumption of 46 per cent when operating on a 4 per cent grade, compared with a level grade; a 75 per cent increase on a 5 per cent grade; and 114 per cent increase on a 6 per cent grade for a 50,000 lb. vehicle. On highways carrying a large proportion of truck traffic, a considerably increased expenditure is, therefore, justified in the reduction of grades. On canyon roads, however, where the summit cannot be lowered, and in order to reduce the grade an increased distance will be necessary, the saving in the operation cost due to the reduction in grade is offset by the increased operation cost due to the extra distance; therefore, no benefit is derived as long as the maximum grade for which the truck is designed and loaded is not exceeded.

Sight Distance.—Is is essential in the design of a highway to obtain proper sight distance. The obtaining of adequate passing sight distance for two-lane roads in rolling or mountainous country for high speed is prohibitive in cost in many locations. In the pamphlet "A Policy on Sight Distance for Highways," published by the American Association of State Highway Officials, the minimum passing sight distance for 70 miles per hour is given as 3200 feet desired, and 2900 feet as the absolute minimum. As the sight distance increases in the proportion of the square root to the length of vertical curves, sight distances where the grade break is appreciable would require extremely long vertical curves, prohibitive in cost. Also, horizontal curves in cuts would be limited to less than one degree. In fact, construction of a four-lane road requiring only a 600-foot sight distance would be much cheaper in many cases. It is, therefore, necessary from an economic standpoint to have non-passing zones on two-lane highways through such territory, which should not be very objectionable if passing zones are provided at frequent intervals. The objection would increase in proportion to the traffic volume and proportionate length of non-passing zones.

Four-Lane Roads.—Construction of four-lane roads is probably justified in country requiring relatively heavy grades, with a considerable less volume of traffic than roads in level country, due the necessity of having no passing zones and due to more passing movements being required, as on the high grades the speed of the heavier type vehicles is greatly reduced over that of passenger cars. Volume of traffic is probably the most important factor. Studies generally indicate a volume of 3,000 cars or more per day justify the wider pave-

ment; however, other factors must be considered. There is considerable difference of opinion as to the traffic volume which economically divides two-lane from multiple-lane roads. A study might be made to determine the actual delay in making passing movements; however, proper evaluation of the time lost would be difficult to determine. Accident rate generally increases with congestion, so accident cost reduction must also be considered in such a study.

Maintenance Cost.—In the selection of projects for construction, one of the factors entering into such selection is maintenance cost; therefore, in the design of the project, consideration should be given to features that will result in lower maintenance costs. Such features would involve flattened slopes and top soiling to prevent erosion, and widening of cuts and providing higher embankments in snow country to reduce snow removal cost. A study of the soil types and water table which would affect the stability of the surface should be made, and, if necessary, the water table should be lowered by drainage; and imported fill material used, if the natural material is unsuitable. Compaction of embankments adds to surface stability and reduction of maintenance costs due to settlements.

Width.—As to the surface type, a study by our Planning Survey shows that a traffic volume of approximately 2,000 cars per day is the economic dividing line between the construction of the cheaper type bituminous surface on gravel base and the rigid pavement. This will vary due to subgrade, stability, soil type, weather, vehicle loads, etc. Due to limited funds, the cheaper surfacing is ofttimes used on roads carrying higher traffic volumes. For safe operation of the highway, the width of the surfacing should not be decreased, as at the higher speeds more room is required for clearances in passing; and 12-foot or 13-foot lanes should be provided on all high-speed 2-lane highways. The use of the wider lane will also result in reduction of maintenance costs in the upkeep of the shoulders. Eight to ten-foot shoulders are desirable on all main roads; however, on some of the lighter-travelled roads, the shoulder width might be reduced if conservation of funds is necessary. The widening of the highway can generally be accomplished at a later date without much increased cost over the original construction.

On 4-lane roads, a wide neutral zone is very desirable. A width of 30 to 50 feet provides clearances for cars crossing the road and U-turns at intersections which will greatly increase the safe operation of the road. Here, again, limited funds often require the adoption of a less expensive design wherein the neutral zone is reduced to as low as 4 feet. In the construction of such roads, the right-of-way cost is often one of the big factors entering into the adoption of the narrower neutral zone.

Roadside Development. — Another feature of design which should be given consideration is the item of roadside development. This might include such landscape features as flattening and rounding of cut slopes, top soiling of excavated areas to encourage natural growth, artificial plantings, rest stations, information signs, etc. Such features would relieve the tension, fatigue, and monotony of driving which contribute to accidents. To make the travel over the highway as pleasant as possible should certainly be given attention.

Other Factors. — Many other features entering into the safety of the road can be incorporated in the design, such as elimination of railroad crossings by structure, elimination of highway crossings, flat fill slopes, wide structures, foot-paths for pedestrians, and highway lighting. It is not always possible, however, to incorporate all of the ideal features into the design of the road, as the design and development of the automobile has been much faster than the development of our highways, and it must be kept in mind that the engineer is always faced with the problem of sacrificing quality for quantity. As long as the funds are limited, such a procedure is economically justified; however, it would result in a saving to the highway user and general public over a period of time were the construction program accelerated and the project designed to include all of the desirable economic features. The life of the highway would, therefore, be greatly increased, highway maintenance decreased, and the present highway accident cost greatly reduced.

In Conclusion

The economic loss due to congestion is estimated at billions of dollars a year in the United States.

Approximately 40,000 lives and a billion dollar property damage bill is the price we pay for highway accidents. These sums could be reduced to a fraction by a properly planned and designed system of highways.

The general benefits derived would tend to stabilize the life of the area served by the highway. Continuous changes in the highway systems disrupt valuations of whole areas. Shipping areas are changed; businesses suddenly lose their entire trade. Shifts in population due to construction or lack of construction of highways often result in the disruption of the existing facilities for community needs such as schools, fire control, sewer systems, water systems, etc.

Therefore, the early construction of a well-planned, adequate highway system will result in a general economic saving as well as savings to the user.

An educational program is, therefore, desirable to convince the public that an economy much greater than the cost will result by providing greatly augmented highway construction funds.

Associated General Contractors Elect New Officers

At the annual convention of the Associated General Contractors of America at Indianapolis, Ind., Feb. 16-18, Dan W. Kimball, president of the Owen-Ames-Kimball Co., Grand Rapids, Mich., was elected president for the coming year. Oscar B. Coblentz, president of the McLean Contracting Co., Baltimore, Md., replaced Mr. Kimball as vice-president. E. M. Rust, vice-president of the Rust Engineering Co., of Washington, D. C., was reelected secretary-treasurer.

New occupational division officers were also elected. William Muirhead, of Durham, N. C., was elected chairman of the Building Contractors' Division, and P. M. Fogel, of Kansas City, Mo., vice-chairman. J. H. Pittman was elected chairman of the Highway Contractors' Division, and W. P. Roscoe, of Billings, Mont., vice-chairman. L. C. Rogers, of Chicago, Ill., was elected chairman of the Heavy Construction and Railroad Contractors' Division, and A. Teichert, Jr., of Sacramento, Calif., vice-chairman.

Gasoline Tax Yields 12 Billion Dollars in 23-Year Period

When the gasoline tax reached its 23rd birthday, Feb. 25, American highway users had contributed 12 billions of dollars from this source alone, of which approximately 10 billion was collected by the states, and about 2 billion by the Federal Government. Most of the state gasoline tax money went to building the greatest system of highways ever possessed by any nation, but the yield from the duplicating Federal levy has been used for general purposes of Government, entirely unrelated to roads.

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ Showing a Baker hand hydraulically controlled road maintainer being pulled by an Oliver "80" diesel tractor along the Burma Road near Rangoon, Burma. It is one of several such units used on road maintenance work there. The road in this section is dirt with a gravel overlay, the gravel ranging in size from fines to 1½ in. Needless to

say, the road is taking an awful beating and these units are practically in daily use trying to keep the chuck holes filled up. New gravel, too, is added from time to time.

• •

¶ The California bridge engineers always have a reason for designing a structure as they do. What alibi they can have for the solid handrail on that bridge on the north edge of Sacramento is probably good. The handrail itself is an abomination—a throw back to 20 years ago.

• •

¶ What I believe is a record in highway design regarding the use of critical materials is now in the mill in Nevada. The state has presented a 21 mile project, costing an estimated $585,000, for certification and it has only $145.00 worth of critical materials on it. This job from Bettle Mountain, west, on U. S. 40, contains an estimate for 2000 lb. of nails and 500 lb. of wire for form work.

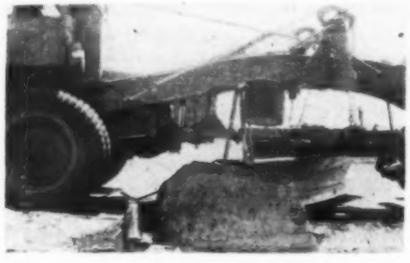
¶ About 20 units of equipment were working on Donner's Pass, on U. S. 40 in California, the morning and previous afternoon before I crossed. They cleared the storm pronto. There's more piled snow in Truckee than I ever saw there before.

• •

¶ I checked that long stretch of road across the mud and salt flats of Utah just east of Wendover. Except for a short bend around a piece of railroad property it is 36 miles long.

• •

¶ Herewith two pictures from California showing a sideview and endview of a new oil-mix beam shaping attachment for a motor grader. The



shaper forms and irons the beam while the rollers immediately following compact it. Pictures courtesy California Division of Highways.

¶ Guard to prevent boys and others from climbing up on batter posts or upper chords of Howard Street bridge,

Baltimore, Md. All similar spots are protected on the other members of both spans.

• •

¶ There were many developments in Nevada that are new since my last visit, such as bituminous gutters along shoulders on fills, wooden curb along edge of roadway on grade separation fill just west of Wells, bituminous paved ditches for 100 or 200 ft. each way from a drainage channel to prevent ditch water from eroding the ditch, long stakes of uniform size and color to designate obstruction for benefit of snow removal crews, long new streamlined sections on U. S. 40, and those new warning signs for curves which say "Advise .. Miles." That word "Advise" is forceful, American, and carries the right spirit.

BETTER HOLD OFF ON IT
HOW YA GONNA PAY FOR THE RIGHT OF WAY ?
RAISE THE CURBS HALF INCH!
THE SIGHT DISTANCE IS TOO LONG !!
LET THEM TAKE THE INITIATIVE !
26 FT. IS TOO MUCH FOR DOWN THERE !!
WE CAN'T MAINTAIN SHOULDERS LIKE THAT !!
I WON'T APPROVE OF ANY THING LESS'EN 26 FT.
REDUCE IT 1/16"
THE LIGHTING SHOULD MOVE OVER 3"
I DON'T SEE HOW WE CAN DO IT
I WON'T AGREE !
UNSCRAMBLE !!
LET'S GO !
Morey

¶ I want to call particular attention to this picture. It is art rather than cartooning. Art, in that it expresses, with finesse, a situation familiar to all highway engineers. While I'm not allowed to say from what state I obtained this picture, it should not be hard to guess. It could be a commission meeting, a district engineers meeting, a bridge engineers meeting, an administrative group, or a road design executive meeting. You could guess the state by following my remarks as I run about the country. Just as you can tell where a train has been because of its tracks, so you can tell where I've been by the remarks. How many times have you heard them?

Contractor Builds Access Road by Management Contract

Heavy Embankment, Wet Cut, Bituminous Gutters, and Bridges on Precast Piles Features of Project

CONSTRUCTION of an access road to the Ogden Ordnance Depot—Riverdale—outside of Ogden, Utah, has been in progress about a year under a WPA contract-management arrangement. The engineering work was done by the Utah State Roads Commission but the WPA acted as agent for contracting the construction work. The job is a little over 3 miles long and contains, besides some heavy embankment and wet cut construction, a continuous concrete slab bridge on precast piling over a power house penstock, and a steel deck girder bridge on precast piles over the Weber-Davis irrigation canal. Minor drainage structures were concrete pipe.

Heavy Embankment

Leaving the ordnance depot the road curved down a 5 per cent grade on a 17 deg. curve around a hill the top of which was used for borrow for the big 128,500 cu. yd. fill. At the deepest place the fill was 50 ft. high as shown by figure 1. Soil investigations were conducted and plotted for the entire length. At a point near the canal it was found that about 2000 ft. of 8 in. concrete subdrainage would be required. The practice in Utah at present is to dig the subdrainage trench along the shoulder of the road about 2½ or 3 ft. deep. Three inches of 1½ in. crushed rock or crushed gravel is placed in the bottom of the trench on top of which the concrete pipe are lined. The pipe is then covered on the sides and top for about 12 in. with this same coarse aggregate. The trench is then filled with the excavated soil. Since the recent Third Annual Highway Engineering Conference at the University of Utah at which Mr. H. E. Cotton, Research Engineer, Armco Products Association submitted a paper on "Wet Subgrades," the State Road Commission has decided to change these sub-drainage requirements. Finer textured backfill material will soon be required instead of the coarse.

The diagram shown in figure 2 is a section of the soils analysis investigation for the same stretch of road indicated by figure 1. An interesting feature of the profile is that the embankment rests on a thick layer of clayey silt under the surface of the natural ground. No subdrainage was provided for this location because no water was encountered in the test holes. The fill material was taken from the top soil of the hill around which the road runs. It was a very sandy soil. Reference to the table on figure 2 will show the thick lowest subsoil to contain 49.5 percent silt and 34.0 percent clay. The fill is rapidly erodable material and porous. Considerable protective structures, as bituminous paved gutters (see figure 3), slope drains, and surface water pickups will be built. Construction has not progressed that far.

On all of the deep fills the natural ground was benched in about 6 or 8 ft. benches as the fill was built.

(Continued on page 48)

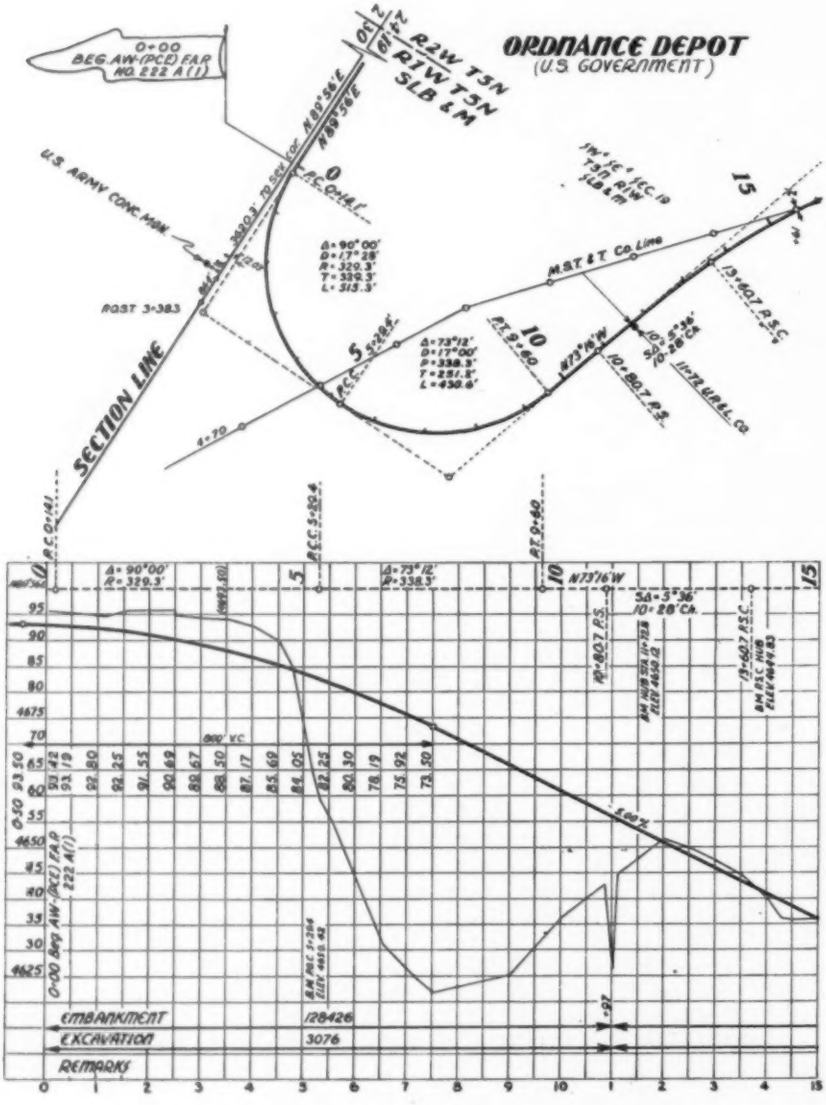


Fig. 1.—Plan and profile of first big fill out of the ordnance plant

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★ By lasting longer, preformed wire rope conserves steel which America greatly needs. For example, it conserved enough steel last year through longer service to make more than 73,000 aerial bombs for our armed forces.

★ Back of the armed forces—in the industries that provide their requirements—preformed wire rope plays an important part by reducing the frequency of machine shutdowns. This wire rope lasts longer, it steadies production, and is easier and safer to handle. It saves both time and money.

★ Preformed wire rope is an essential to American industry—a necessity for the Nation.

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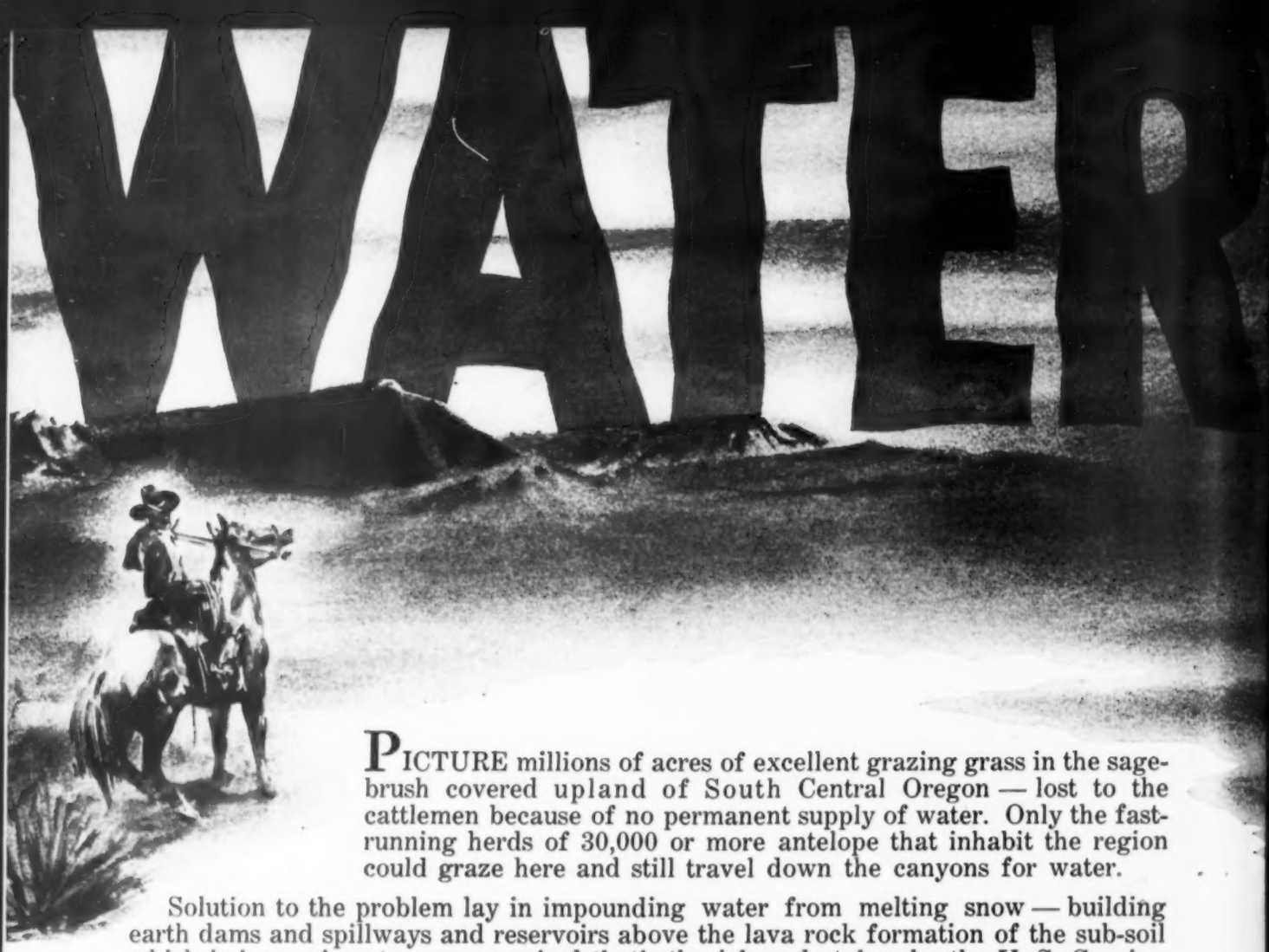


PICTURE millions of acres of excellent grazing grass in the sagebrush covered upland of South Central Oregon — lost to the cattlemen because of no permanent supply of water. Only the fast-running herds of 30,000 or more antelope that inhabit the region could graze here and still travel down the canyons for water.

Solution to the problem lay in impounding water from melting snow — building earth dams and spillways and reservoirs above the lava rock formation of the sub-soil which is impervious to seepage. And that's the job undertaken by the U. S. Grazing Service with outstanding results. This organization moved in with Allis-Chalmers HD-10 Diesel Tractors equipped with Buckeye Unitilt Trailbuilders to move 2,000 to 10,000 cubic yards of earth for each of a series of dams spaced approximately 2½ miles apart throughout the region. Then the dirt began to fly!

In one section, the Grazing Service conservatively estimates that 5,000 head of cattle can now be grazed, while the cattle owner who will use the area estimates that he will be able to run as high as 10,000 head.

You'll find many a Buckeye Cable Controlled 'Dozer on jobs like this—hundreds of miles from everywhere where durability, speed and economy count. There's a model for your tractor. Write to Buckeye for specification data.

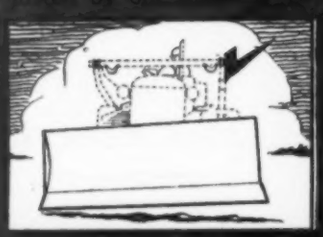
BUCKEYE TRACTION DITCHER COMPANY, Findlay, O.

IT'S TWO IN ONE!

Bulldozer or Trailbuilder on a universal frame! Just change the blades — a quick job accomplished by pulling two kingpins. Frame also accommodates Unitilt mounting plate.

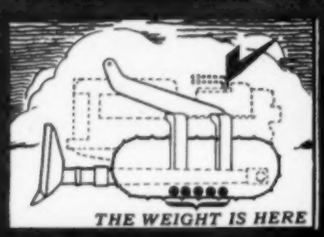
IT TILTS!

Bulldozer as well as Trailbuilder tilts! You can use the Bulldozer moldboard for many types of trailbuilder work. Patented tilting device is easily adjusted by one man.



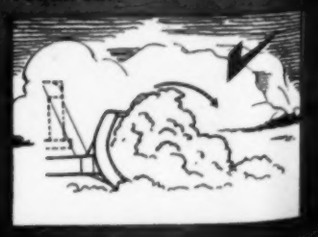
IT "HUGS" THE RADIATOR!

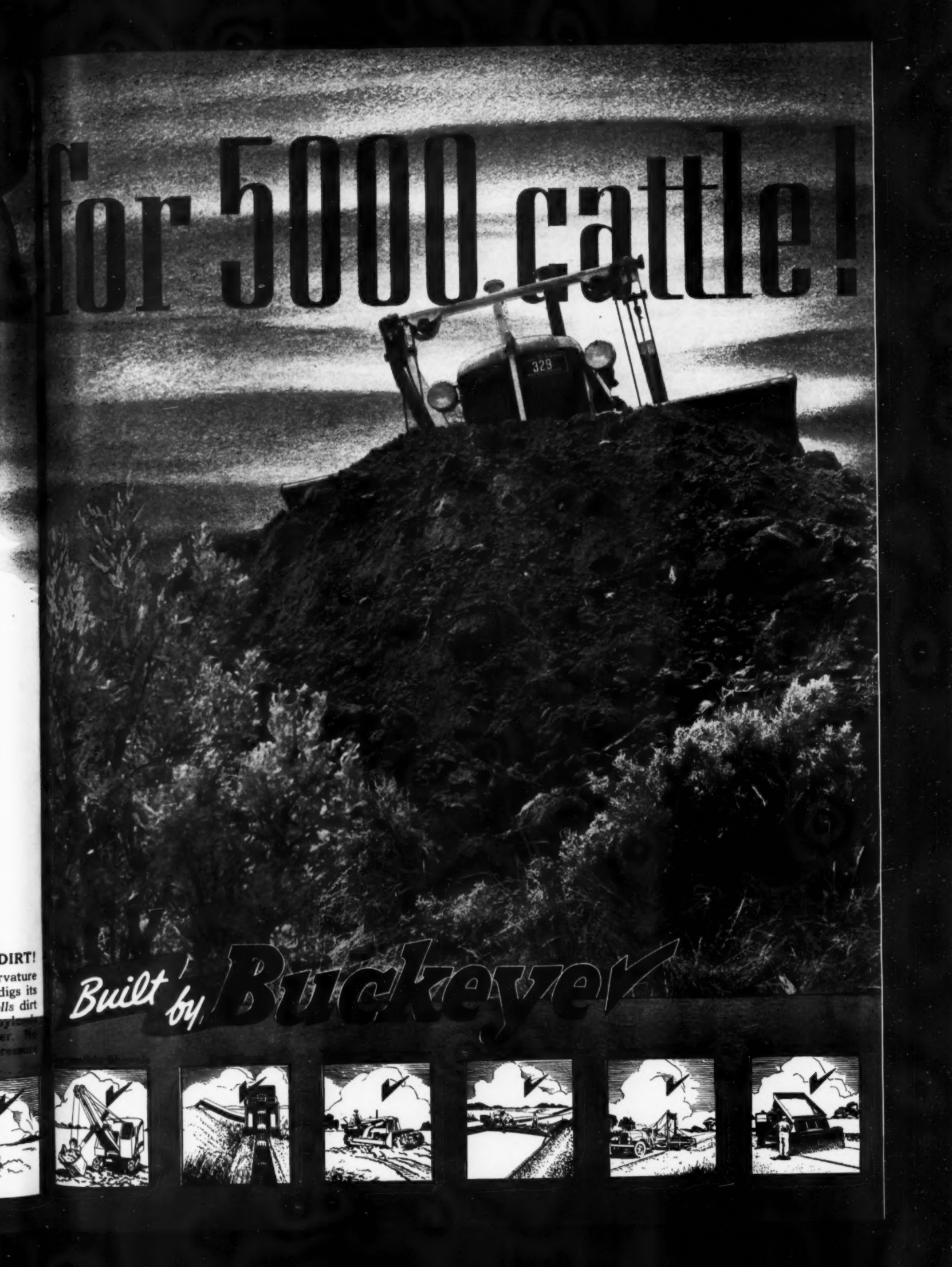
Blade hangs close to tractor — tractor stays in balance with weight where it belongs — reduces wear on front track rollers — provides better traction.



IT ROLLS THE DIRT!

Buckeye blade curvature is such that blade digs its own way in and *rolls* dirt ahead for big loads with the same power. No mechanical down pressure required!




for 5000 cattle!
329
Built by Buckeye

Soil was placed in about 8 in. layers and compacted to 90 percent of Proctor optimum with twin sheepsfoot rollers. The contractor used from one to three roller outfits, as required, to get the proper compaction which was checked by the inspector at regular intervals. Between 5 and 9 passes were usually sufficient.

In one cut ground water encountered caused so much trouble that the scraper outfits bogged down. It has not yet been drained but will be.

Cross Sections

A typical cross section is shown in figure 4. It will be noted that the Utah practice is to grade the top flat, even in cuts, and to haul sub-base, base, and surfacing material thereon to raise the grade for providing side ditches. When completed, 12 in. of surface material has been placed. The surface will consist of 2½ in. of bituminous material with a sidewalk provided on one side for part of the way. A cross section of the sidewalk construction is shown in figure 5. The bituminous gutter will also be installed on all superelevated curves.

For the base course the aggregate must not exceed a 45 percent wear test with the Los Angeles rattler. It meets the following gradation:

	Percent
Passing 2 in.	100
Passing 1 in.	60–100
Passing No. 4	30–60
Passing No. 200	3–15

For the surfacing material the aggregate must not exceed 40 percent in a Los Angeles wear test. It meets the following gradation:

	Percent
Passing 1 in.	100
Passing ¾ in.	85–100
Passing No. 4	45–65
Passing No. 10	30–50
Passing No. 200	5–15

Equipment and Contract Prices

The contractor is Strong and Grant of Springville, Utah. He is working, also, at nearby Hill Field. For this job he contracted with the WPA on the basis that bid items would cover all work on a cubic yard basis in which the WPA paid rental on equipment per cubic yard. The items were:

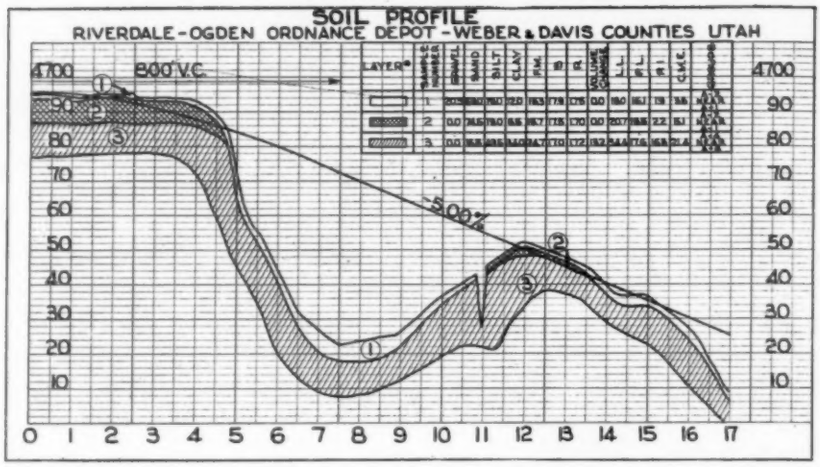


Fig. 2.—Soil profile of the same stretch of road covered by Fig. 1 in which the heavy embankment is shown

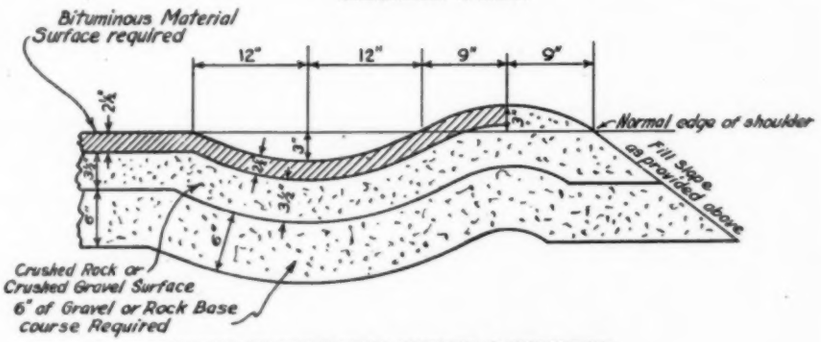


Fig. 3.—Paved gutter and shoulder protection on fills will be made of bituminous mixture

Rental equipment per cubic yard	$0.14
Class A haul (up to 1,000 ft. sta. yd. beyond 500 ft. free haul)	0.0075
Class B haul (yd.mi. haul beyond 1,000 ft.)	0.15

The WPA furnished unskilled labor for clearing and grubbing, for finishing backslopes, for installing subdrainage, and for construction and installation of bridges and culverts.

The contractor furnished the following equipment on the grading work, that which is now in progress:

Two 8 yd. Tournapulls
Three 16 yd. Le Tourneau scrapers, hauled by
Three D8 Caterpillar tractors, and loaded with
One D8 Caterpillar tractor with bulldozer
Three D6 Caterpillar tractors with twin sheepsfoot rollers
Two 12 ft. Caterpillar motorgraders
One ¾ yd. power shovel
Two 1½ yd. dump trucks
One grease truck
One fuel tank truck.

Continuous Concrete Slab Bridge

The line had to cross the penstock tubes of a power company. This crossing was made with a continuous concrete slab superstructure resting on concrete caps which held together precast piles made with Union Metal Manufacturing Company fluted pile forms. The sketch shown by figure 5 is a general drawing of the structure. Figure 6 shows the general arrangement and length of piling used in the abutments. For the abutments six 16-in. piles were driven and poured but for the 3 intermediate bents eight

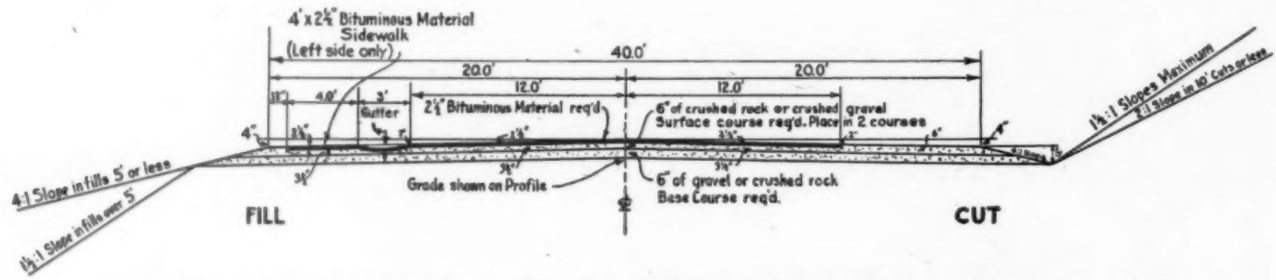

4" x 2½" Bituminous Material Sidewalk (Left side only)
40.0'
20.0'
12.0'
12.0'
20.0'
Gutter
2½" Bituminous Material req'd.
6" of crushed rock or crushed gravel Surface course req'd. Place in 2 courses
Grade shown on Profile
6" of gravel or crushed rock Base Course req'd.
4:1 Slope in fills 5' or less
1½:1 Slope in fills over 5'
1½:1 Slopes Maximum
FILL
CUT

Fig. 4.—Typical cross section. Note how a gutter is provided on the section where a walk is placed on one side

When time counts

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Speed up the job—with Blaw-Knox Clamshell Buckets—they handle more pay load with less dead weight. The rigid head maintains cable alignment and prevents wear—sealed ball bearing sheaves in the lever arm increase cable life, reduce friction and expensive replacements.

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- FERTILIZER BUCKETS
- CEMENT PLANT BUCKETS
- FOUNDRY BUCKETS
- SEWAGE DISPOSAL BUCKETS
- CINDER AND ASH HANDLING BUCKETS
- PULPWOOD GRAPPLES
- SHIP'S TACKLE BUCKETS

BLAW-KNOX DIVISION of Blaw-Knox Co.
Farmers Bank Bldg., Pittsburgh, Pa.

"Headquarters for Clamshell Buckets"

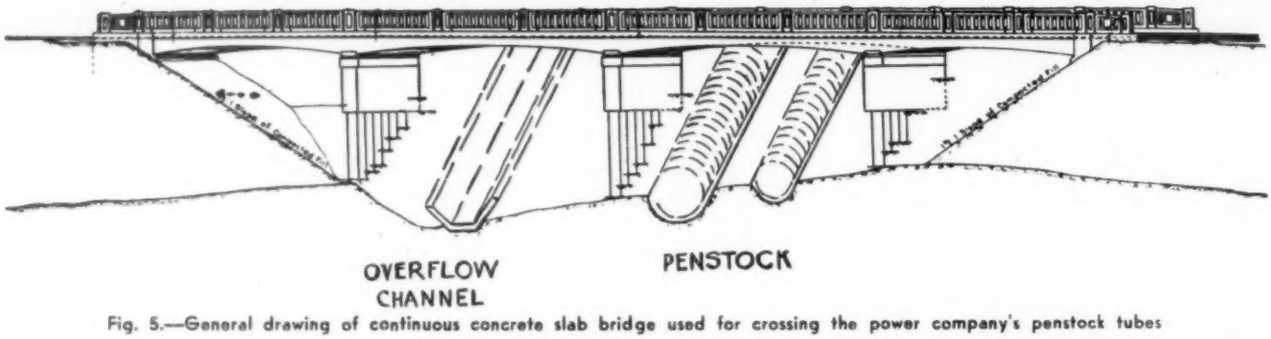

Fig. 5.—General drawing of continuous concrete slab bridge used for crossing the power company's penstock tubes

18-in. piles were used per bent. About 25 ft. penetration was obtained for each. Because of the proximity of the penstock anchor, piles were employed rather than to disturb the natural soil slope by digging for heavy abutment construction. The span was fixed at the center and expansion provided at the ends through 1½-in. expansion joints between the slab and the backwall.

A Vulcan steam hammer was used for driving the shells, steam being provided by an auxiliary boiler as shown in figure 7, since a gas power crane handled the leads. The penstock tubes and canal overflow channel as shown in figure 8. To drive the piles, a falsework crossing was first built upon which the crane operated.

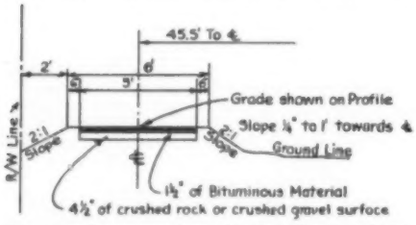

Fig. 6.—Cross section of sidewalk provided

Fig. 7.—Showing the driven Union Metal piling shells covered before being filled with concrete. The boiler in the background furnished steam for the Vulcan hammer

Steel Deck Girder Bridge

To cross the Weber-Davis irrigation canal a 79 ft. 4 in. single span steel deck girder bridge was constructed. The abutments for this structure were also driven out of the Union Metal Mfg. Co. piling.

A feature of this structure was the conversion of 30 in. by 200 lb. I-beams into girders by cutting the web and splicing in a flat piece. This is shown

Fig. 8.—Penstock tubes and canal overflow channel which the bridge crossed

by figure 10. The web was cut longitudinally and a 13¾-in. strip of flat steel welded into the web. Then 4-in. by 3½-in. by ⅜-in. angles were welded on for web stiffeners, thus converting an I-beam into a deeper girder. This procedure provided the 44-in. depth required for the span.

On both of these bridges a unique procedure for curing the concrete in the pile shells was employed. The weather was quite a bit below freezing, near zero. After the pile shell was filled with green concrete a square framework was built on top of it and Sisalkraft protective paper thrown over the framework and pile like a tent. The ground contact was closed and oil burning salamanders put under the tents. The idea worked fine, the blackened steel shells were easily cleaned off for painting of all area above ground.

Engineering

Field engineering work was under the supervision of Resident Engineer C. R. Kimball of the Utah State Road Commission; W. L. Anderson is Road Design Engineer and Paul Master, Bridge Engineer. Mr. H. C. Jessen is the engineer for the WPA.

Fig. 9.—A falsework trestle was built to carry the driver over the crossing to where it could get hold of the piles and start driving

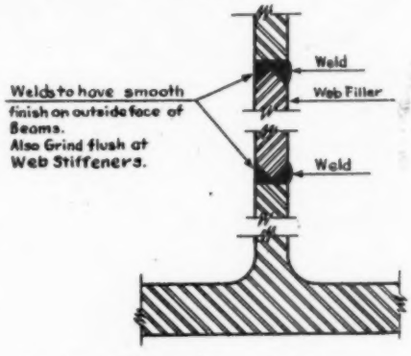

Fig. 10.—Typical welding detail for web filler. Web stiffeners were then welded to the sides to convert beam into a girder

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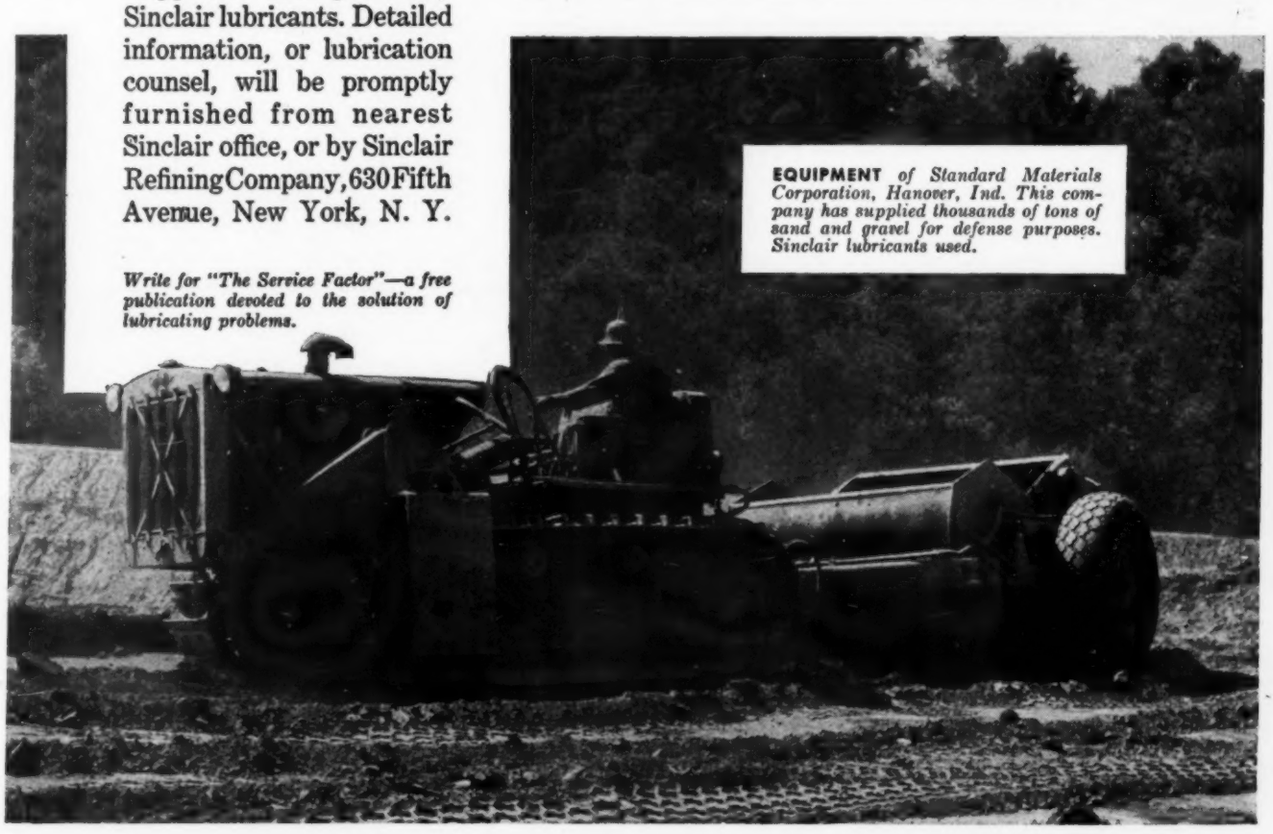
. . . SINCLAIR PENNSYLVANIA and OPALINE MOTOR OILS, also specialized gear oils and greases promoting top yield of continuous service hours under the most punishing operating conditions. For stepped-up machine output and stepped-down shop costs try Sinclair lubricants. Detailed information, or lubrication counsel, will be promptly furnished from nearest Sinclair office, or by Sinclair Refining Company, 630 Fifth Avenue, New York, N. Y.

Write for "The Service Factor"—a free publication devoted to the solution of lubricating problems.



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Maintenance Organization Aids Defense Project

By M. B. HODGES
Maintenance Engineer
Texas Highway Department

AT various times the Texas State Highway Department is placed to a severe test of efficiency and organization. On December 29, 1941, at a conference in Bastrop, Texas, the Department was officially notified by Army officials that an Army camp was to be constructed near Bastrop. It was to be the largest in Texas and one of the largest in the Nation. The total estimated expenditure was $24,000,000 and the work was to be performed in four months after award of contract. Bids were to be opened on January 19 and work must be started within two days after award of contract and execution of bond and contract. An estimated 15,000 to 25,000 employees would be necessary to complete the work within the time specified. To us this meant very heavy traffic on those highways leading into Bastrop as housing facilities in this small city were insufficient for even 1,000 employees. The time was insufficient for us to consider reconstructing any of the highways which might be considered as inadequate for the volume of traffic which is anticipated during the camp construction period but it was decided to place a seal coat and non-skid surface on approximately forty-four miles of highways within the immediate vicinity of Bastrop.

Bids were closed on December 31 for the necessary materials, the bids having been received by wire. Approximately 9,000 tons of stone and 600 tons of asphalt were required. The low bidders were notified by telephone as to the urgency of the work and that we expected full compliance with delivery specifications.

Distributor on U. S. 290, west of Bastrop, squirting binder for non-skid seal coat

Truck supply for stone chips kept spreader busy

Action Starts

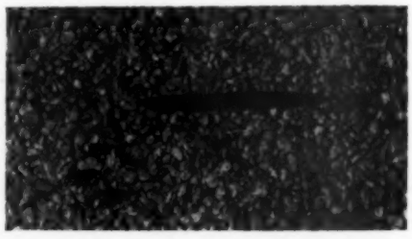
Complete asphalt units, including distributors, heating plants, spreader boxes and rollers, were secured from Districts 13 and 22. Arrangements were made for these units to report to Bastrop on the evening of January 14 and be ready for work on the morning of January 15. In the meantime stone shipments had been started and trucks of District 14, this being the District in which Bastrop is located, were unloading the material and delivering into stock piles at intervals of one mile on those highways to be sealed.

The company receiving the order for the asphalt was notified by telephone on the afternoon of January 12 to start asphalt shipments and everything was in readiness on the morning of January 14 to start work. No asphalt had arrived nor did any arrive until the evening of January 17 when six cars arrived about 8:00 p.m. Due to rains that night and on the morning of January 18, it was impossible to perform any work on that date. The weather cleared, however, during the afternoon of January 18 and the work was actually started on the morning of January 19.

The six cars were unloaded and used on January 19 and 20 and again we incurred a loss of one day, January 21, for lack of asphalt. It appeared that the company would be unable to furnish in accordance with delivery specifications and arrangements were made to secure 200 tons of the material from another company and this material arrived in Bastrop on the afternoon of January 21. Work was resumed on the morning of January 22 and the work completed about 3:00 p.m. on January 24. Slightly more than five and one-half days were consumed in the placing of the seal coat and non-skid surface on approximately forty-four miles of pavement.

The seal coat and non-skid surface called for the application of 0.30 gals. of RC-2MA cutback asphalt per sq. yd. and covered with a rather coarse aggregate at a rate of 1 cu. yd. of material to 110 sq. yds. of pavement.

Spreader box distributing broken stone chips on U. S. 290



Texture of completed surface

Completed seal coat on U. S. 290 between Bastrop and Paige

GALION CONTRIBUTES TO SMOOTH TAKE-OFFS— HAPPY LANDINGS . . .

Galion tandem rollers have contributed no little part in the many smooth take-offs and happy landings; building many miles of runways, aprons and taxi-ways in airport construction. They cover a lot of ground while compacting thousands of tons of asphalt.

There is no let-up now in our "All Out for Victory" program . . . and that's always been characteristic of Galion road machinery . . . hard at it day after day until the job is completed. During 1942 and until the final peace . . . all of us have a big job in front of us . . . so let's keep in there pitching every minute.

Galion road machinery is doing it's part . . . are you?

Motor Graders—three models, diesel or gasoline power.

Road Rollers—tandem, 3-wheel, portable, sheepsfoot and trench.

Spreaders—for laying asphalt, mulch, stone, gravel, slag to even depth and width.

GALION ROAD MACHINERY
points to better roads

THE GALION IRON WORKS & MFG. CO.
MAIN OFFICE AND WORKS: GALION, OHIO

Ordinarily an oil asphalt is used for this type of work but due to cool weather it was deemed advisable to use a cutback. In an effort to secure a non-skid surface the stone was graded as follows:

	Per cent
Passing a ¾ in. screen	100
Retained on a ½ in. screen	20- 30
Retained on a ¼ in. screen	70-100
Retained on a 10-mesh sieve	98-100

In using a cutback asphalt it was also considered advisable to use crushed stone for cover material as previous experiences had taught us that crushed gravel, especially with a high percentage of siliceous material, has very little affinity to the cutback asphalt with a resulting loss of most of the cover material. For experimental purposes on this project we used one car of crushed gravel.

Reminder

It is not our thought or idea that the work which was performed is permanent in any sense of the word. A greater percentage of the mileage so

Men responsible for speedy surface treatment job, left, Mr. Joe A. Russell, District Maintenance Engineer, District 14, and right, Mr. Victor Searcy, District Maintenance Engineer, District 22

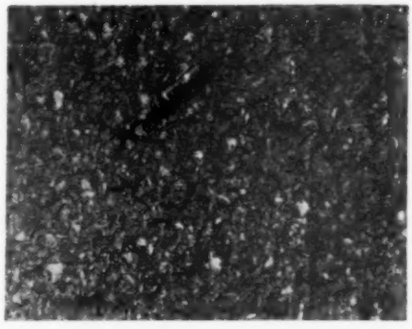
treated consists of light asphalt treatments on an inadequate gravel base and which has required extensive maintenance in the past. We are merely trying to protect the present investment; reduce maintenance costs during the period of heavy traffic and provide a non-skid surface in an effort to reduce accidents due to skidding.

Shaving Puts New Face On Pavement

Two years ago, the Main Street of Alhambra, California, was improved by the heater-planer process. The area affected was in the heart of the business district. The street had become smooth and slippery in the traffic lanes, while next to the curb there were many depressions, some to a depth of three inches, caused from parked cars.

Having had adverse criticism from the merchants in previous years for repairs and construction of the pavement during business hours, it was planned to do this planing at night time. The work schedule called for an eight hour shift, starting at 10:30 p. m. and finishing at 7:00 a. m. with a 30 minute lunch period. This new time schedule received the hearty approval of all the merchants and aided the workers materially because of less traffic.

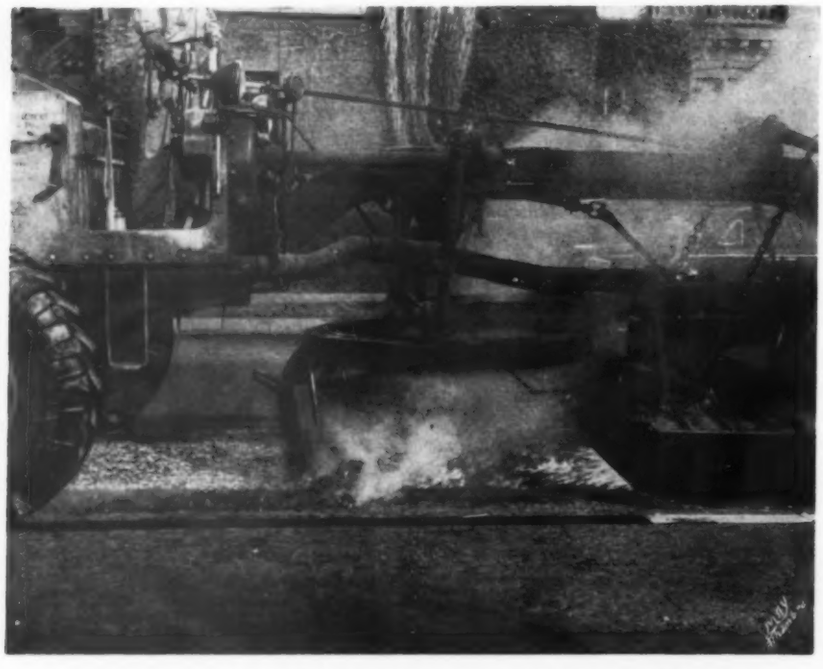
The machine used in the planing was a large, specially built motor grader with a long wheel base. A fuel-oil-fired furnace was constructed in the forepart of the machine with a high tensile strength cutting blade placed immediately in the rear of the furnace. This cutting blade did all the planing, as cutting of the fat spots and corrugations, leaving the displaced materials in a continuous windrow at the side of the cut. (The material planed from the pavement was picked up by a crew of men following the planer and stored until the next day. These cuttings were spread over unimproved alleys making a very satisfactory dust settler). The planer is propelled by a heavy duty diesel motor, which also supplies the oil and air pressure for firing the furnace.



Finished non-skid surface resulting from heater-planer operation

The pavement was planed to a depth which eliminated all the depressions in the traffic lanes and about 75 per cent of the depressions caused by parked cars. The remaining depressions adjacent to the curb were then filled with asphaltic concrete. This work, because it was completed with such speed, and done mostly at night time, received numerous compliments as well as making a big hit with our merchants.

After two years service this pavement still retains its non-skid, mosaic surface to the entire satisfaction of the city officials.



Planing rough asphaltic concrete pavement in Alhambra, California

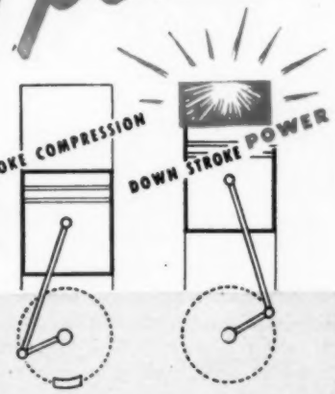
New Route for Alaskan Highway Proposed

A "middle-route" halfway between the routes previously advocated by the United States and Canada for the Alaskan Highway has been recommended for immediate construction to both President Roosevelt and Canadian Prime Minister W. L. MacKenzie King by the Canadian-United States Joint Defense Board. The project would require upwards of $25,000,000.

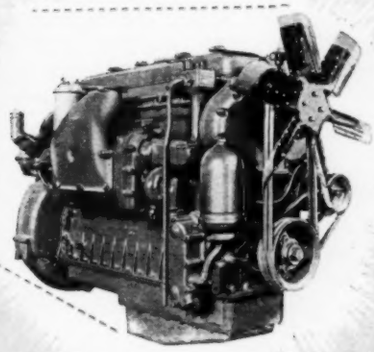
2-CYCLE DIESEL

It's Double-hitting power

.. POWER IN EVERY DOWN STROKE



You eliminate exhaust and intake strokes on a 2-cycle Diesel. Fresh air is forced in by a blower and exhaust gases expelled while piston is at the bottom of the stroke. Every up stroke is a compression stroke . . . every down stroke a power stroke.



No wonder the 2-cycle Diesel has so much zip and power and smoothness . . . no wonder it's the modern Diesel power! It develops twice as much power as a 4-cycle Diesel with an equal number of cylinders, and the same bore and stroke, operating at the same crankshaft speed. Thus, a 3-cylinder engine is the equivalent of a 6 . . . a 6, the equivalent of a 12! The result is smoother operation and far greater hanging-on ability—the outfit keeps moving when the going gets tough. There's less gear shifting, too! You can throttle down to half the rated engine speed and still maintain your lugging power . . . also, pick up top traveling speed in a hurry. There's less upkeep, too! Two-cycle smoothness is easier on engine parts, and easy on the equipment. Half the number of cylinders means half the maintenance . . . greater simplicity! Get all the facts on this modern Diesel power. Write for catalogs on 2-cycle Diesel tractors and the Model AD Motor Grader.

• • •

3 SIZES . . . HD-7, HD-10, HD-14
60 TO 132 DRAWBAR HORSEPOWER

ALLIS-CHALMERS
TRACTOR DIVISION · MILWAUKEE · U. S. A.

2-Cycle
THE MODERN DIESEL POWER

Lifeline of the New World—The Pan American Highway

THE shift in the balance of power occasioned by the war in Europe and Asia and its spread to the New World is altering the basic economics and military patterns of the Western Hemisphere. In this titanic international clash, the unfinished Pan American Highway* will soon assume a major role in the defense of the Americas.

Stretching 16,000 miles from the Arctic frost of Alaska, the highway winds its way across the lofty 16,000-foot heights of the Andes cordillera on the Pacific slope of South America down to the dusty Argentina pampas and through the steaming jungles of Brazil. The great international artery traverses 19 countries in North, Central and South America, and will ultimately include Cuba and the insular American Republics in a transmarine highway extension of the Pan American Highway system.

At the recent Fourth Pan American Highway Congress held in Mexico City, a resolution was unanimously passed urging the dedication of the Pan American Highway on October 12, 1942, to commemorate the 450th anniversary of Columbus' discovery of America.

Projected dedication ceremonies would not imply completion at that date nor early inauguration of through traffic over the vast trunk route linking all the Americas. They will reflect, however, the unified determination of all countries to drive through to realization this greatest international highway with least possible delay. The roadway is about 87 per cent complete in Central and South America for use during the "dry-weather" season. Several large sections are in constant service in Mexico, Panama, Colombia, Peru, and Argentina. The other republics, in cooperation with the United States, now are preparing facilities assuring safe, convenient, economical travel passing from one country to another.

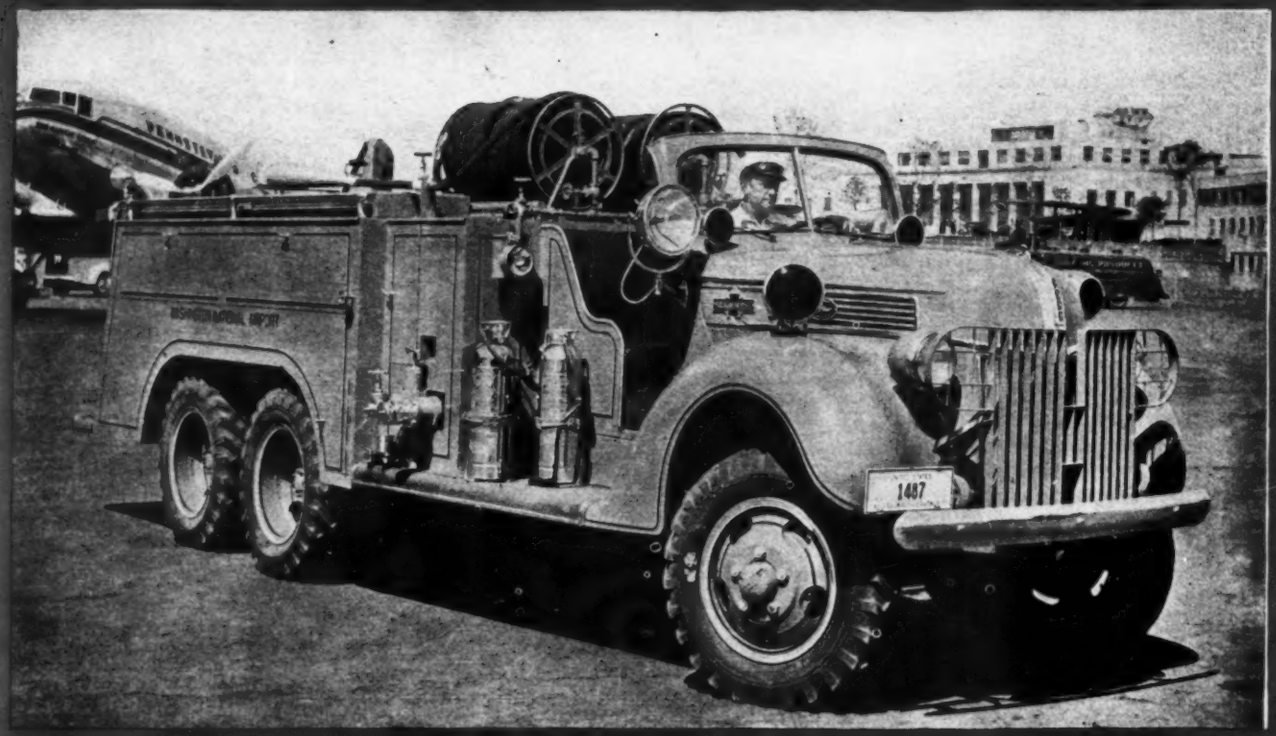
The highway, in view of the declaration of war by the United States and nine other American republics against Japan and the European Axis powers, will have an earlier defense utility to the countries along its route. The Trans-Isthmian Highway, paralleling the Panama Canal, will soon connect with the Pan American Highway system and may be expected to play an important part in the canal's defense.

Military Importance

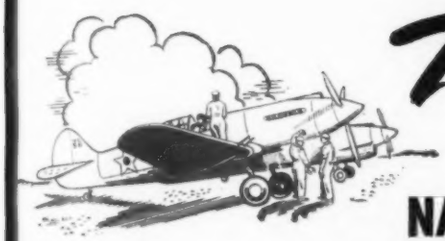
As the medium for moving large armies and vital military equipment to endangered areas in the Western Hemisphere, the highway's value for defense is of supreme importance to all the American republics. Its value doubles upon realization that, without certain important basic raw materials necessary to the Army and Navy and major United States industries, United States efforts to achieve hemisphere military and economic security would be seriously handicapped. Substantial amounts of these strategic materials were formerly obtained from the Far East. With great military and naval battles generating in the Pacific area, transoceanic sources of supply are less dependable.

South and Central American supplies are of incalculable present and

*This article was taken from the "Foreign Commerce Weekly" issued by the Department of Commerce dated January 24, 1942.



MARMON-HERRINGTON *All-Wheel-Drive*



. . . and the NATION'S AIRFIELDS

Grim with determination to build and maintain an air force superior to that of any combination of foes, America must have and maintain thousands of landing fields stretching almost round the world. Service, *on the ground,* is as important as in the air, and for all of the jobs encountered in building and keeping these fields in readiness, Marmon-Herrington *All-Wheel-Drive* trucks are proving supreme. The greatly increased traction of *four or six wheels driving instead of two,* gives ability to perform across open fields in all kinds of weather, to take crash trucks to the scene of accident, to remove snow and sleet from runways, to refuel planes any place, and do scores of other jobs, faster and more dependably than any other vehicles can operate. Many sizes and types, illustrated in new literature, just off the press. Write for it.

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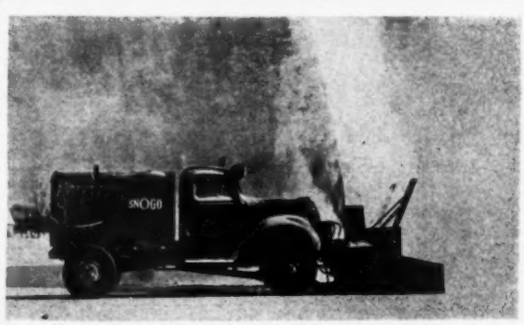


Unequalled ability for airport snow removal service.

Extreme traction for worst going in construction and maintenance.

MARMON-HERRINGTON COMPANY, Inc., Indianapolis, Indiana, U. S. A.

potential value to the United States. The Army and Navy Munitions Board lists 14 strategic materials "for which strict conservation and distribution control measures will be necessary." These materials are antimony, chromium, coconut-shell char, ferrograde manganese, manila fiber, mercury, mica, nickel, quartz crystal, quinine, rubber, silk, tin and tungsten. All of these strategic military materials are part of the great natural resources of the American Republics.

The United States is also dependent on South and Central American products to fortify its peacetime economy. The other American republics have a virtual monopoly on United States imports of bauxite, bananas, Brazil nuts, carnauba wax, castor beans, coffee, chicle and many other products supplying key American industries with indispensable raw materials. By improvement in transportation and communication, these products will become increasingly available for United States industry and for trade within South and Central America as well. The Pan American Highway will be an important factor in making this possible. Constant widening of the "critical list" of raw materials for consumers goods in the United States and further restrictions of priorities will inevitably make South and Central America resources a more significant element in the war efforts as time goes on.

The coincidence of the near completion of the Pan American Highway and the outbreak of hostilities with Japan has not been overlooked by the 21 American Republics and Canada. Measures to rush completion are under way. The Export-Import Bank of Washington has recently extended large loans to Central and South American countries for this purpose. Abortive Nazi and Fascist propaganda efforts to discourage completion of construction in Costa Rica and Nicaragua only serves to focus more attention on the tremendous importance of this project for inter-continental security. Every mile of road constructed and every dollar spent by United States tourists and commercial interests in Central and South America constitute a cumulative blow to the efforts of the aggressive Nazi-Fascist policy of creating and dominating a military and economic hegemony over the Western Hemisphere. Every ton of goods purchased from Central and South American nations by the United States is a ton which the Axis will never get.

The Pan American conception which created this great artery of friendship is an unexampled monument of unity and cooperation among nations. This foresight may be amply justified by the shape of things to come. Not only in time of war, but in time of peace, will this cooperative achievement serve to secure the economic welfare and the security of democratic institutions in the Western Hemisphere.

Workmen breaking rock for section of road in Guatemala. Photo courtesy Ing. Carlos E. Bickford, Guatemala

Construction Measures

Measures to speed construction have been undertaken by the United States in cooperation with the governments of Mexico, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama.

On November 19, 1941, Secretary of Commerce Jesse Jones, as Federal Loan Administrator, announced an agreement had been reached establishing credits by the Export-Import Bank up to $30,000,000 to aid Mexico in constructing and developing its national system of roads and highways, including sections of the Inter-American Highway from Mexico City to the border of Guatemala, and from Nogales on the California-Mexico border to the City of Guadalajara. Mr. Jones pointed out that the system of national highways in Mexico is being developed not only as a medium of travel for the increasing number of citizens of the United States who visit Mexico on pleasure and business, but also as a vital link in hemisphere defense.

American tractor working on rock cut in Central America

More recently Congress authorized the appropriation of $20,000,000 to enable the United States to assist other governments of the Central American republics to construct sections of the Pan American Highway passing through their territories. In Secretary of State Cordell Hull's letter to President Roosevelt suggesting the need for immediate construction, he pointed out the principal reasons why he considered it desirable for the United States to make a direct financial contribution to the completion of the Central American section of the highway. He stated his reasons as follows:

Reasons for U. S. Interest

1. **Improved transportation within and between the several countries and the United States.**—This will increase commerce between the various countries—for example, by providing a means of transportation of Costa Rican fruits, vegetables, and coffee to Panama. Practically every year there is a shortage of some staple crop such as corn, rice, or beans in at least one of the countries of Central America. An inter-American highway would provide a cheap and efficient means of transporting products from other countries to the country in which a shortage existed. Imports from the United States of the staple crops just mentioned are negligible, but improved transportation and the resulting increase in capacity of consumption would provide additional markets for American products.

2. **Development of new lands and new natural resources, and increased consumption of American imports.**—Improved transportation in these countries will develop new areas and new resources and will provide better connections with ports at which American steamship lines call. There should result a notable increase in tourist traffic to the United States and imports from the United States through these ports.

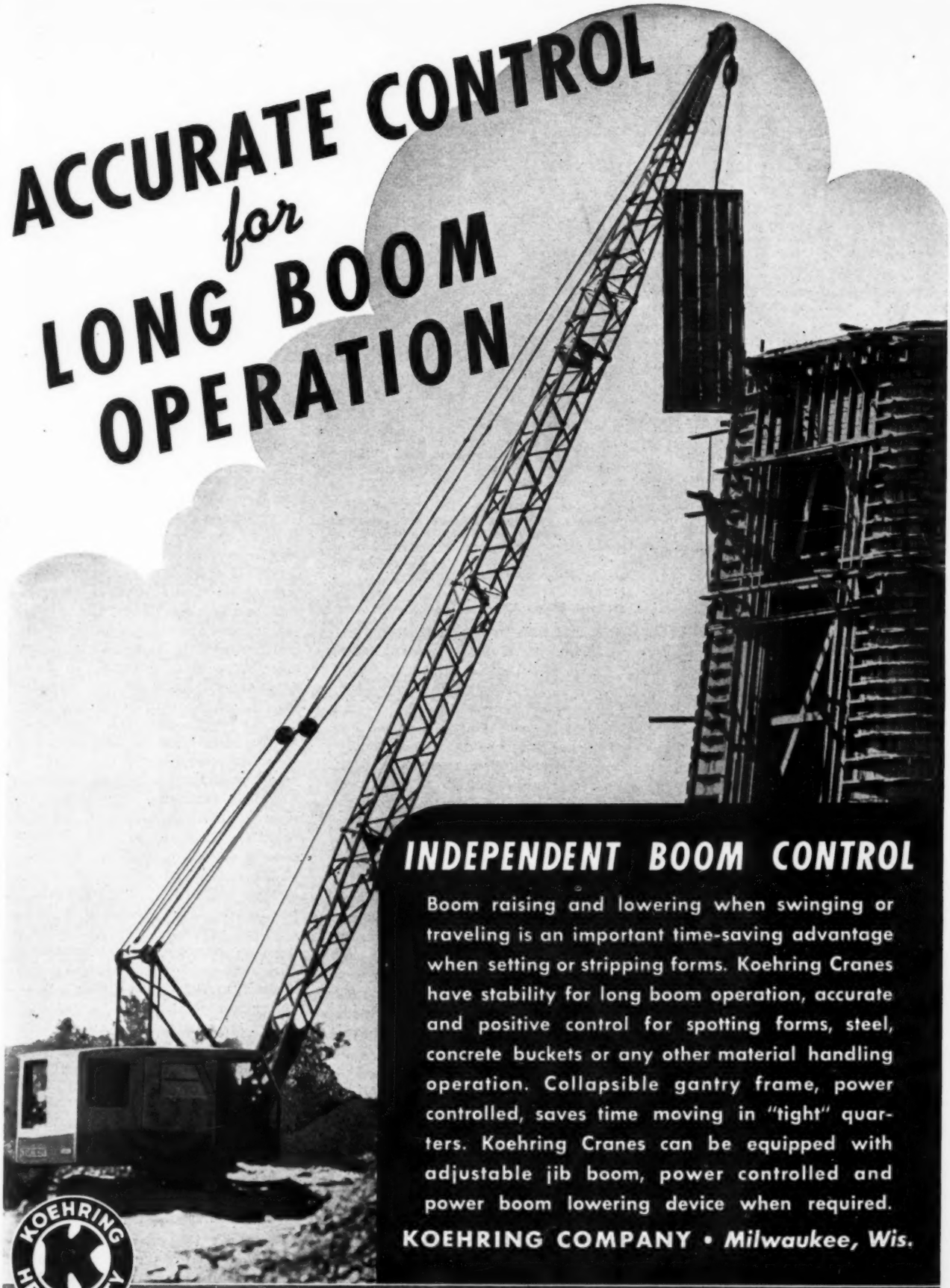
3. **Increased employment and maintenance of economic structures.**—Road construction and new enterprises made possible by improved transportation will provide employment in the present period of economic difficulty. Most of the Central American countries are dependent on bananas and coffee to meet their foreign-exchange requirements and, with the European market practically closed to them for the present, it is to the mutual interest of the United States and of the Central American countries to take all practicable measures to maintain the economic structures in Central America.

4. **Increased tourist traffic.**—It may be predicted that tourist traffic would greatly increase from the United States, especially as far south as Mexico and Guatemala, and that similar traffic from these points to the United States would also show a notable growth. The value of tourist traffic is recognized both from an economic standpoint and as an exchange of cultural influences.

5. **Increased market for American automobiles, parts, garage equipment, etc.**—The opening up of the highway extending through Mexico and Central America to the Canal Zone would result in a greatly increased market for American passenger automobiles and trucks. The machinery and equipment used in garages, filling stations, and the parts and accessories required, would also be important items of American exports.

6. **Defense value.**—While defense con-

ACCURATE CONTROL *for* LONG BOOM OPERATION



INDEPENDENT BOOM CONTROL

Boom raising and lowering when swinging or traveling is an important time-saving advantage when setting or stripping forms. Koehring Cranes have stability for long boom operation, accurate and positive control for spotting forms, steel, concrete buckets or any other material handling operation. Collapsible gantry frame, power controlled, saves time moving in "tight" quarters. Koehring Cranes can be equipped with adjustable jib boom, power controlled and power boom lowering device when required.

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KOEHRING HEAVY DUTY

HEAVY-DUTY CONSTRUCTION EQUIPMENT

siderations have not motivated the suggestion for an outright contribution by this Government to the construction of a highway, the War and Navy Department believe that a through highway from the United States to the Panama Canal would be of real value from the standpoint of the defense of the Caribbean area. The importance of political stability in all the countries of the Western Hemisphere at this time can hardly be exaggerated and this is in turn largely dependent upon the maintenance of economic stability. The project contemplated by this proposed legislation will contribute directly to the maintenance of order, as improved communications will give the established governments in these countries materially more effective control over any attempted subversive activities within their borders and the actual work of construction would substantially assist in safeguarding the economic situation in these countries.

The Inter-American Highway section in question is approximately 1,550 miles in length. The proposed route reaches from the Panama Canal to the border between Guatemala and Mexico and passes through the capital cities of every country except Honduras, where a road which would connect the capital city to Tegucigalpa with the Inter-American Highway is already in service.

The highway through Central America would connect at the border between Guatemala and Mexico with the Mexican section of the Inter-American Highway and provide direct communication by road from Laredo, Texas, to the Canal Zone.

Expanding Trade with South America

In 1938, when Germany's panzer divisions began their onslaughts against the Polish armies, United States imports with Latin America, expenditures for travel, scenery, recreation, and services from Central and South America totaled $485,335,000. It is estimated that the total for 1941 of United States imports was about one billion dollars. It may be expected that the Pan American Highway will do much to supplement the expansion of the United States merchant marine in handling the increased volume of trade between the Americas.

Export-Import Bank loans, United States government appropriations and earmarked funds by Central and South American nations will probably total $78,365,000 for current Pan American Highway construction.

The breakdown of the above sum is as follows:

A $30,000,000 loan to Mexico by the Export-Import Bank of Washington for construction in southern Mexico and the western section of the Pan American Highway in Mexico from Nogales to Guadalajara. A $20,000,000 appropriation recently authorized by Congress for completion of construction of the Pan American Highway in Guatemala, El Salvador, Honduras, Costa Rica, Nicaragua, and Panama. This $20,000,000 appropriation is contingent on the matching of funds by the Central American nations concerned in the ratio of $1 for every $2 the United States has set aside for construction.

Prior to the Mexican loan and the Congressional appropriations other loans and United States government appropriations to Central and South American countries totaled $18,365,000 for construction of the Pan American Highway.

First stage of completed road through rough terrain in Central America. Next step is to bituminize the surface

Other Benefits to the Americas

In addition to the benefits gained by Secretary Hull's reciprocal trade treaties with Latin America, expenditures for travel, scenery, recreation, and services rendered United States tourists have developed a great flow of needed funds to our "Good Neighbors." Potentially, a large share of the United States tourist expenditures may be diverted to South and Central America. The American tourist dollar receives maximum purchasing power in Central and South American countries.

Normally, United States citizens spend $500,000,000 in foreign travel and 11 times this amount in domestic travel. During 1939, only 14 per cent of these travel expenditures were made in the nations south of the Rio Grande. Only $10,000,000 was spent in South America by United States citizens, which represents only 2 per cent of the aggregate total spent in the tourist-and-travel trade. With international conditions tending to confine travel to the Western Hemisphere, the permanent flow of travel within the Americas is a next logical step. The war may last a long time, and during this period, the Americas can take this important means of repairing their cultural and economic fences.

To complete the Inter-American Highway in Central America approximately $80,000,000 will eventually be expended. To construct and equip hotels, restaurants, gasoline stations and tourist camps, to provide mechanical repair services and other facilities now largely nonexistent but necessary for travelers, potentially, $200,000,000 or more could be spent. With the expenditure of these large sums, mostly in actual cash, these moneys will be utilized again and again in commercial transactions with the United States and for intra-Central and South American trade. Thus, whatever sums are expended in Latin America will increase in expansive volocity to a huge volume of permanent credits and dollar exchange. At the same time, as the volume of travel increases, more funds will be made available to each of the other American republics to complete and improve their sections of the Pan American Highway and for the purpose of extending auxiliary highways to tap untouched, important mineral and agricultural producing areas in the interior. The economic, military, cultural, and political significance of perhaps hundreds of thousands of United States citizens spending hundreds of millions of tourist dollars and commercial funds in Central and South America, bolstering a weakened economy, cannot be overemphasized. For the first time it will be possible to create the actual physical intermingling of the peoples of all the Americas. These peoples now unified by the surging impulse to defend the continent against treacherous aggressors may soon have the opportunity of exchanging individually the firm hand-clasp of solidarity.

Through the medium of the Pan American Highway, the face-to-face relationships in trade, travel, and cultural exchange for which Pan American groups have striven for so long, can now be accomplished more easily.

Particularly in these troubled times, the highway affords an unparalleled opportunity for United States tourists and travelers to implement the good-will efforts which have been so important a part of United States foreign policy toward the other twenty American republics.

Costa Rica to Spend $8,000,000 to Complete Inter-American Highway

The State Department announced on January 16 that the United States would cooperate in the construction of the Inter-American Highway through Costa Rica. In accordance with the agreement and the diplomatic exchange of notes, Costa Rica will assume at least one-third of the cost of construction. The remaining two-thirds cost will be assumed by the United States.

This is the first exchange of notes under the provisions of the act of December 26, 1941, authorizing the expenditure by the United States of $20,000,000 for the purpose of cooperating with the five Central American Republics and Panama for the completion of construction of the Inter-American Highway (the Central American Section of the Pan American Highway System) through their territories. The Costa Rican Minister of Public Works and Agriculture, Alfredo Volio, came to Washington to negotiate the diplomatic and financial arrangements.

It is understood that of the total Congressional appropriation of $20,000,000, Costa Rica will receive $5,400,000. In the note handed to Secretary Hull by Luis Fernandez, Minister to the United States from Costa Rica, it was stated that Costa Rica is committed to assume at least one-third of the cost of construction of the road, and to this end has completed financial arrangements with the Export-Import Bank of Washington under which it has received a credit of $2,200,000. The expenditure of this sum is limited to construction work on the Inter-American Highway in Costa Rica.

The note also set forth that Costa Rica owns road-building equipment, materials, and other unused road-building supplies valued at $400,000. This material will be made available by the Costa Rican government for work on the highway.

The Department of State also announced that assurances embodied in the law of December 26, 1941, are being sought from El Salvador, Guatemala, Nicaragua, Panama and Honduras in order that financial cooperation may be extended to these nations.

An "all-weather highway" has already been completed across Guatemala. Funds allocated to Guatemala will be used to improve its existing highway. During the past year substantial progress has been made in El Salvador. A hard-surfaced road has been completed over a major part of its section of the highway. In Nicaragua the route from Sebaco to Dirianba by way of Managua, capital of Nicaragua, will soon be finished in Costa Rica. In Panama the Rio Hato section of the highway will probably be completed during the summer of 1942. This route runs approximately 80 miles from the Panama Canal to Rio Hato, site of a large United State airport now under construction.

In Secretary of State Hull's reply, he set forth that it was the intention of the United States to extend to Costa Rica the cooperation envisaged in the law, subject to appropriation of funds by the Congress of the United States. Upon receipt of necessary assurances from the other American republics specifically designated under the law, they, too, can receive financial assistance.

In his note Mr. Hull stated, "You are, of course, aware that by the terms of the law the survey and construction work authorized shall be under the administration of the Public Roads Administration, Federal Works Agency. It is understood that you are now making a subsidiary agreement with the Administration to carry out this provision of the law."

In PUMPS, the BEST COSTS YOU the LEAST

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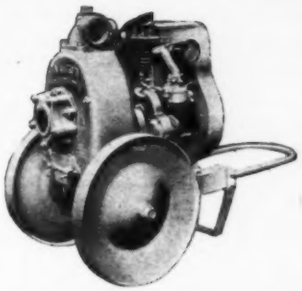
Every Jaeger Pump is Individually Tested and Guaranteed for Vacuum, Capacity and Pressure

THOUSANDS of EXTRA HOURS of SERVICE for Your Future Protection as Well as Profit



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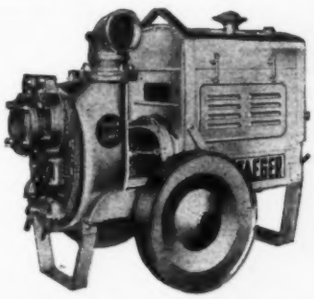

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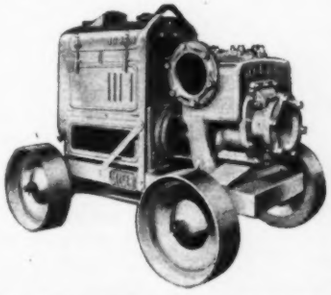

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2. REPLACEABLE LINERS.

3. PAT'D PRIMING JET, gives up to 5 times faster sure-priming.

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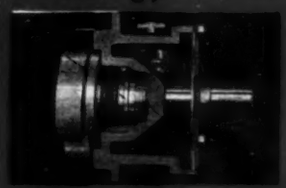
5. OVER-SIZE SHAFTS of heat-treated chrome nickel.

6.



"LONG-LIFE" SEAL — accessible for inspection.

7. DIRECT DRIVE, ALWAYS IN ALIGNMENT — adds life to pump and engine.

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Manager, Lubricant Division
Standard Oil Company of California

GENERAL interest in keeping diesel motive equipment operating efficiently for long periods at the lowest maintenance cost is due to the relatively large investment and greater cost of repairs. This is particularly true today because of the war situation, with its attendant restrictions on availability of new equipment and repair parts. Therefore, now more than ever before, diesel operators are interested in the most efficient possible operation of their equipment.

This article is mainly concerned with high speed diesel engines—that is, engines of 1,000 rpm or higher—and comments will be confined essentially to that type, except to state that the general problems of lubricating slower speed diesels are similar but modified in degree. However, all diesels involve the same basic lubrication problems and answers.

Why Is There an Unusual Lubrication Problem in High Speed Diesels?

All diesel users are familiar with the general operating principles of the diesel engine. However, it is appropriate briefly to review its basic points of difference in comparison with spark ignition engines of corresponding size and general type. Both are heat engines utilized for the same purpose, but the diesel, because of its design, is also just about the best possible set-up for oxidizing lubricating oil. Heat and air are the major enemies of lubricating oil, and the more heat that is applied to an oil in the presence of air the greater is its tendency to oxidize and form sludge, gum and other contaminants.

In a diesel engine, for example, temperatures at the end of the compression stroke are much higher due to greater compression pressures. These pressures average 450 to 550 pounds per square inch in comparison to 90-120 pounds per square inch in spark ignition engines. In general, there is an increase in temperature above that of the atmosphere of about 2 degs. F for each pound increase in compression pressure. Thus, 500 pounds compression in a diesel engine would generate a temperature of about 1000 degs. F.

Due to the method of charging fuel to the cylinders, the spark ignition type engine is cooled during the suction stroke by vaporization of the fuel, but this effect is absent in diesels.

The net result of these differences is that temperatures in diesel engines are much higher than in spark ignition engines. The maximum temperature at the top of the piston is about 700 degs. F. The temperature of the top compression ring generally ranges from 475 degs. F to 490 degs. F and in the four-compression-ring type piston the temperature of the bottom compression ring will be around 380 degs. F. Generally speaking, temperatures at corresponding points in spark ignition engines will be from 25 to 75 degs. F lower. The rate of oxidation roughly doubles with each 20 degs. F increase in temperature. Thus, the high speed diesel inherently subjects the lubricating oil to as much as sixteen times the oxidation tendency.

Furthermore, the diesel always operates with excess air (oxygen). In the throttle control type of engine a full charge of air is fed into the cylinders only when the engine is under maximum load and as a result there is normally little or no excess oxygen in the gas mixture after combustion or in the blow-by gases. Diesels, however, compress a maximum amount of air at all loads and excess oxygen is always present; in fact, diesel blow-by generally contains about 90 percent air.

Due to these severe operating conditions, contaminating deposits resulting from deterioration of the lubricating oil are generally formed at a comparatively high rate in diesels. These deposits form and stay in place on the hot metal surfaces or are carried in the oil stream. Efficient filters will remove the latter, but the former interfere with proper piston operation, affecting both oil distribution and engine compression. Such deposits tend to collect behind and around the rings and also clog the oil grooves or holes through which the lubricating oil is supposed to return to the crankcase.

Another adverse effect of such deposits is their interference with heat transfer. In all types of internal combustion engines a major portion of the heat absorbed by the head of the piston is passed off through the rings to the oil film, through the oil film to the cylinder wall or the cylinder liner, and then into the cooling water. Any deposits collecting around the rings will interfere seriously with this necessary heat transfer, resulting in further increase in piston temperatures which, in turn, increase the tendency of the lubricating oil to oxidize and form additional deposits. The ultimate result of this process is stuck rings, large power loss, high blow-by, piston drag, etc.,—all of which mean overhaul and repair expense. Possible increased use of cast iron pistons to replace aluminum may also aggravate this tendency due to inherently poorer heat transfer.

Another source of deposits in diesel engines is the formation of carbonaceous particles resulting from incomplete fuel combustion. During the exhaust stroke, such particles are present around the top of the piston and, because of the high pressure (around 500 pounds) during the compression and power strokes some of these particles are forced back of and around the rings. Such deposits are in addition to those described above from lubricating oil and aggravate the situation outlined. The two-cycle diesel engine equipped with superchargers, due to its more effective scavenging, generally experiences less trouble from such particles than the conventional four cycle diesel.

Crankcase oil temperatures in diesels reflect the more severe temperature conditions in the cylinder area, and frequently reach 240-250 degs. F. Preferred crankcase oil temperatures are about 180 degs. F, high enough to insure good fluidity and freedom from "cold" sludge due to water condensation and yet not so high as to increase oxidation unduly. Various methods can be used to keep the crankcase oil temperature down, such as provision for greater crankcase capacity, oil coolers, etc. However, it should not be inferred that maintenance of crankcase oil temperatures at 180-200 degs. F will insure satisfactory diesel lubrication, as this has only a very minor effect on oil temperatures in the critical upper cylinder area. To illustrate, oxidation

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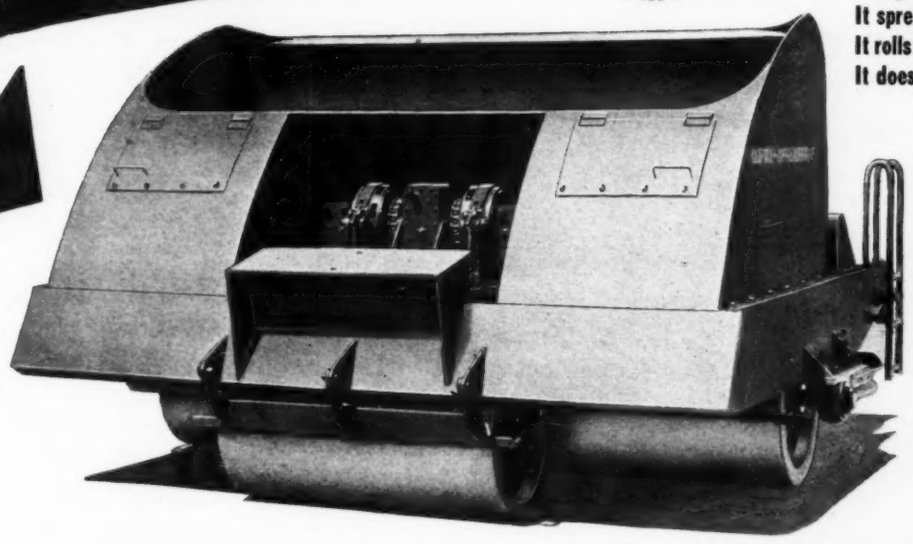

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conditions on the lubricating oil are about 65,000 times as great as 500 degs. F as at 180 degs. F.

Another basic difference between diesel and spark ignition-engines affecting lubrication has to do with oil distribution over the cylinder walls. In spark ignition engines existence of a partial vacuum in the combustion space during the intake stroke assists materially in drawing oil toward the upper compression rings. In diesels, however, atmospheric pressure prevails in both the combustion space and crankcase during the intake stroke; therefore, lubricating oil distribution throughout the cylinder is a greater problem in diesels.

Why Not Use Straight Mineral Lubricating Oils in Diesel Engines?

A lubricating oil has three major functions in an internal combustion engine—to lubricate, cool and seal. The performance of these functions may be seriously affected by the presence of contaminants from outside or within the engine. Outside contaminants may come from the intake air or from faulty combustion. Such contamination can be controlled by proper filtering, proper type of fuel, ignition, and correct mechanical adjustments. These factors have no direct relation to the lubricating oil proper.

What characteristics must the lubricating oil itself possess in order to satisfactorily lubricate high speed diesels? Briefly, it must have maximum ability to resist deterioration due to contact with heat and oxygen and must possess maximum ability to stay on very hot metal surfaces. In addition, the oil must, of course, have the correct viscosity, low carbon content, low pour point, etc.

However, even the best straight mineral oil available today will not meet these requirements adequately. There has been a great advance during recent years in the technology of manufacturing lubricating oils, and the oils produced today in a modern refinery are infinitely superior in quality to those available a few years ago. Nevertheless, such straight mineral oils, while very much superior in oxidation resistance and in ability to lubricate hot metal surfaces than formerly, still do not come up to modern requirements on these points for the present day high speed diesel engine. Such engines will operate with this type of oil—but for a much shorter period and at much higher overhaul and maintenance costs.

Use of Compounded Lubricating Oils in Diesel Engines

The use of compounded oils in industrial service is not new but few operators realize that compounded automotive oil was introduced fifteen years ago. In 1926, a specially compounded oil was developed to stop the "chattering" encountered in operating Model "T" Fords. Straight mineral oils could not eliminate the difficulty, but the compounded oil—elementary though it was—"did the trick."

Several years later automotive engineers began intensive development work on a high speed diesel engine satisfactory for use in farm equipment. Outside of the usual design and operating difficulties invariably encountered in such instances, it was soon found that sticking of the piston rings was occurring so frequently that maintenance costs were making operators and manufacturers alike wonder if the high speed diesel was practicable.

During this time the oil companies had been working intensively on the development of a specially compounded oil which would be stable enough to resist the terrific oxidizing action of the high speed diesel engine. After testing thousands of blends, announcement was made in 1936 of the first modern "detergent" compounded diesel engine lubricating oil.

Due to the large power output of the high speed diesel engine, some of the manufacturers of this equipment had gone to the use of special alloy bearings. While the new compounded diesel engine oil had solved the problem of ring sticking, it unfortunately could only be used with engines having babbitt bearings as it was corrosive to special alloy bearings. Development work was therefore continued in an attempt to find a "non-corrosive" compounding and in March, 1939, after three years of additional intensive research, the Standard Oil Company of California introduced the first compounded diesel engine lubricating oil for use with any type of bearing.

The type of compounding generally used in industrial oils consists of animal or vegetable fats and acids or occasionally lead, sulfur and chlorine compounds. These are incorporated to increase such characteristics as oiliness, tenacity, film strength, etc., of oils used in steam cylinders, bearings, gears, and similar services. However, it is obvious that none of these conventional compounding agents would be satisfactory under the high temperature and severe oxidizing conditions encountered in diesel engine cylinders and bearings. An entirely new type of compounding had to be found.

This new type of compounding utilizes metallic "soaps." It is not a single chemical compound but rather a com-

plex mixture of several compounds, each of which has been chosen for the effect it will have on the whole. The very fact that many years went into its development indicates that it must be carefully matched to the type of base oil employed. Naturally, the most suitable type of oil is chosen as a base.

Many compounds which are non-corrosive when used with one base oil may become quite corrosive if employed with some other oil. Furthermore, due to the different chemical nature of compoundings used by various manufacturers, mixing of different types of compounded oils should be avoided.

How does this compounding material work? In the first place, it is an excellent anti-oxidant. This means it helps the lubricating oil base further to resist deterioration from heat and oxygen, thereby minimizing the formation of deposits in the engine interior. Secondly, it increases greatly the ability of the compounded oil to stay on very hot metal surfaces. Third, it has a decided "detergent" action which results in keeping the engine cleaner than ever before.

This oil is said to have a "detergent" action because the compounding literally acts like a cleansing soap (detergent) in carrying away dirty deposits from engine surfaces. It must be realized that any lubricating oil, even the best type of compounded oil, still will deteriorate slightly under diesel engine conditions. Therefore, detergent action is necessary to clean out deposits from other sources or from other oils previously used, as well as to keep the engine clean during further operations — and only by keeping the engine clean and free from deposits can it be maintained in efficient operating condition with minimum maintenance cost.

Another outstanding effect of using compounded oils is reduced wear. This results from generally better lubrication due to the effects described above.

Unusual Characteristics of Compounded Diesel Engine Lubricating Oils

Due to the way in which the compounding operates, it is used up gradually. It is therefore necessary to maintain reasonable drain periods. In general, manufacturer's recommendations in this respect should be followed. At first glance it might appear that this would increase costs, but actually the very great benefits accruing from reduced maintenance expense and longer periods between overhauls far outweigh any increase in oil expense.

Compounded oils all produce a more stable foam than that formed by straight mineral oils. They do not generate foam in any greater amount than uncompounded oils of the same viscosity, but the foam lasts longer and, therefore, it appears that compounded oils foam more.

One result of the detergent characteristics of compounded diesel oils is that the drainings always appear dark or black. This is normal and should be expected, as one essential purpose of the compounding agents is to "keep the engine instead of the oil clean." Due to this characteristic, it is also possible to use such oil to good advantage for purging engines which have become very dirty from the use of other types of less stable oil. When doing this, suitable precautions must be observed to avoid possible difficulty from excess deposits that may find their way into the oil stream.

There is no simple method of laboratory analysis which will determine the value of compounding materials of the type described. The following remarks on this subject by H. C. Mougey of General Motors Corporation are of interest:

> "Unfortunately, there are no standardized chemical laboratory tests by which we can predict the performance of oils under heavy-duty service. . . . The final measure of quality always must remain 'performance in service.' However, it is possible to make engine tests under controlled conditions; and, from the results of these engine tests, very good predictions as to performance in the various kinds of service can be made."

In other words, service tests and results are the only criterion that can be used. Therefore, it is necessary for the operator to rely on the engine manufacturer and oil company for guidance in the selection and use of compounded diesel engine lubricating oils. For example, both the Caterpillar Tractor Company and the General Motors Corporation have standardized long time engine tests at high loads as a criterion of the performance characteristics of compounded oils in their diesel engines.

There are, of course, many "compounded" lubricating oils on the market, and too much care cannot be exercised in distinguishing between them. The service record and performance of such oils, as previously indicated, is of primary importance and should be reviewed carefully before any decision is made as to use of the oil in question.

Incidentally, it is significant that both the Navy and the Army have recognized the necessity of using modern detergent compounded diesel engine lubricating oil in their high speed diesel equipment and have issued complete specifications covering such requirements. These specifications are based primarily on actual engine tests.

Future Trends

The prediction of future trends is always difficult, but it seems safe to predict that diesels will continue to increase in power output and will develop especially along the line of supercharging. All such trends will increase further the requirement for great stability of the lubricating oil and its ability to stay on extremely hot metal surfaces to fulfill its function. In this connection, comments made by Mr. G. A. Rosen, Assistant Chief Engineer of the Caterpillar Tractor Company, are significant:

> "The future calls for diesel engines of higher loading, higher speeds, and in some cases, small packages. These tendencies all raise the temperature level of operation and lead to higher localized temperature concentrations. Supercharging and two cycling mean higher flows of air charging to the engine cylinders which will increase oxidizing tendencies. Operating economy is ever on the alert for extended hours of oil change or longer life for a given crankcase capacity. This trend calls for greater stability to guard against deterioration influences."

Similar trends will be apparent in spark ignition engines. All modern cars and trucks today should use a modern detergent compounded lubricating oil of the type described for best operation, and such an oil will probably be essential in the cars and trucks of tomorrow, whether diesel or spark ignition.

▼

British Highway Fatalities Increase.—Two years of war and blackouts have brought steady increases in British highway fatalities according to reports from London to the U. S. Dept. of Commerce.

▼

Florida Levies Tax on Human Vanity.—Florida is levying a tax on what amounts to human vanity. All Sunshine State motorists who want automobile license numbers to match their address, telephone number, their class in college, or what-have-you, will be required to pay an additional $1 in registration fees. The revenue produced will go to support of dependent children.

Moving A Million Yards of Wet Clay

HAMPERED almost continually by recurrent rains that drenched the hills and lowlands of central Minnesota and turned the clay soil to a sodden, heavy gumbo, the Strom Construction Company of Moorhead by dint of perseverance and good equipment moved more than three-quarters of a million yards of dirt during late summer and autumn months to bring their 11-mile grading contract between Hamel and Rockford on TH 55 to within 77.5 per cent of completion by December 14 when winter forced a shut-down. This $187,000 contract for the Minnesota State Highway Department includes almost a million yards of heavy dirt excavation.

This project is an integral link of a new superhighway extending into the heart of Minneapolis and drawing not only from the heavily populated suburban areas immediately surrounding the city, but fitting into a larger scheme of four-lane highways fed from the central and northwestern sections of the state. One major section of the super-highway — the "Olson Memorial Highway" — was completed at a cost of $300,000 in 1940. This one and one-half mile project within the Minneapolis city limits provides two three-lane asphaltic concrete roadways with opposing lanes of traffic separated by a landscaped island. It was the first section of the complete envisioned TH 55 reconstruction program in a northwesterly direction from Minneapolis. Right now, other sections between Minneapolis and the Strom contract are under construction.

The Strom contract is a new alignment, replacing a narrow, winding bituminous surfaced road with a wide, modern highway. For the last mile of the project, as the road approaches Rockford, the old alignment is followed, but the remaining 10 miles is entirely new grade.

Fig. 1. — Loading 5 yd. Ford truck with Caterpillar 48 in. elevating grader on close-in side borrow

Fig. 2. — Le Tourneau scraper and Caterpillar tractor loading in heavy clay

It has a shoulder-to-shoulder width of 42 feet, is designed for a 38-foot wearing course, and includes a temporary gravel wearing course. The gravel is used to help consolidate and stabilize the roadway prior to blacktopping. Ditches along the new grade are wide and shallow, and backslopes are flattened.

Quantities included in the Strom contract give some idea of the scope of the work being done. Class "C" excavation totals 929,622 cu. yds., with 10,859 cu. yds. of sand-gravel fill and 14,142 cu. yds. of stabilized fill. Material from the several cuts along the grade is unsuitable for fill, necessitating sub-cuts and boosting haul on the job to 4,217,983 sta.-yds. of overhaul. All fill is coming from cuts and side borrow.

Move Outfits In

The contractor started his crews stripping with a Caterpillar 48-inch, power control, elevating grader which he shortly followed with two complete dirt moving outfits. The first outfit consisted of a power shovel-dragline unit and 10 trucks and the second of eight crawler tractors and large wheel scrapers. Despite the rain that started when the job was started and continued right on through until the snows came, the contractor managed to average about 5000 cu. yds. a day during initial operations with two eight-hour shifts and later boosted production to almost 10,000 yds. a day with three shifts of eight hours each.

Where close-in side borrow went directly to embankments the Caterpillar elevating grader, pulled by a Caterpillar "75" tractor, loaded six Chevrolet trucks and four Ford V8 trucks. The 10 trucks, equipped with five-yard dump bodies and all seeing their first service on this project, had maximum hauls of about one mile.

The second equipment outfit was comprised of seven Caterpillar D8 tractors with Le Tourneau 12-yard scrapers and one International TD18 tractor with a Bucyrus-Erie nine-yard scraper. These units worked principally in the cuts and sub-cuts, hauling a maximum of 1000 feet to the fill. With several cuts along the 11-mile stretch, the largest was about 27 ft. deep. The clay soil in many of the cuts was heavy and difficult to handle. To assist in loading the scrapers the contractor used the International tractor with a Bucyrus-Erie bulldozer attached as a "pusher."

At one section, the new grade dips through the lowlands between Rockford and Hamel and here the contractor used a Lorain "75" 1½-yd. dragline for swamp excavation. Subgrade excavation for side borrow fill in the swamp section required 464 dragline hours of operation.

As the fill for the new grade was dumped in truck and scraper loads and from the bucket of the dragline, an Austin-Western "99" motorgrader and an Adams leaning wheel grader smoothed out the dump and shaped

Fig. 3. — International TD18 tractor with Bucyrus-Erie bulldozer used as "pusher" in loading heavy clay

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Fig. 4 — Allis-Chalmers Farmall tractors towed twin sheepfoot rollers for compacting

the grade. The fill was compacted in four-inch layers by two tandem sheep-foot roller units, each pulled by an Allis-Chalmers tractor. The continual movement of the heavy, pneumatic tired pieces of equipment over the grade provided added compaction.

Equipment Service and Results

Approximately 30 men were employed to a shift with two eight-hour shifts running during the first weeks of operation and three eight-hour shifts as the work progressed. Equipment was carefully serviced and checked on the job during each shift and a portable greasing outfit completely greased each unit every eight hours. When repairs on the equipment were needed, mechanics with pick-up trucks made minor adjustments on the job site or major repairs at the completely equipped repair shop maintained at Hamel.

With so many days of bad weather and so many large pieces of equipment tied up on this project, the Strom Construction Company made a determined effort to waste not a single day of the precious few days of good working weather. Careful attention to the manufacturers' recommendations regarding oil changes and lubrication avoided many breakdowns, and the use of oil filters on the equipment prevented abrasive wear on the engines. The use of preformed wire rope increased cable life and materially reduced the amount of time spent in splicing or replacing scraper and shovel rope.

The Le Tourneau 12-yd. scrapers were equipped with 9/16-in. preformed wire rope. Strom, like many other contractors, has discovered that the long life and flexibility of preformed cable over the small scraper sheaves and the ease with which it may be handled and changed is a decided advantage. Despite the severe stresses coupled with short radial turns on both the shovel and the scrapers, the preformed wire rope outlasted an ordinary type cable by a ratio of almost two to one.

When the fills have been completed the whole road will be given a temporary wearing course of 14,142 cubic yards of gravel. A permanent wearing course of blacktop will be applied later under another contract. At Hamel, the new highway will join another similar section completed in 1940.

Personnel

Personnel on the job includes Chester Jacobson of Ashby, construction superintendent for the Strom Construction Company, and his brother, Gilford, dirt foreman. Project engineer for the Minnesota Department of Highways is Robert Clark.

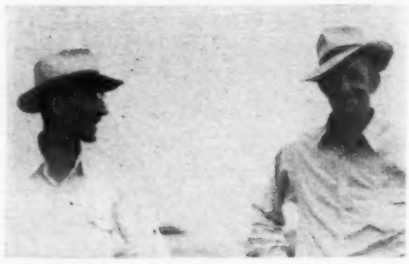

Fig. 5.—Left, Robert Clark, project engineer. Right, Gilford Jacobson, dirt foreman for Strom Construction Company

Equipment

Strom's equipment on the Hamel-Rockford contract includes:

- 7 Caterpillar D8 tractors with 12-yd. Le Tourneau scrapers
- 1 International TD18 tractor with Bucyrus-Erie 9-yd. scraper
- 10 Ford and Chevrolet 5-yd. dump trucks
- 1 Caterpillar 48-in. power control elevating grader
- 1 Caterpillar 75 tractor
- 1 Adams leaning wheel grader
- 1 Austin-Western "99" motorgrader
- 2 International TD18 tractors with Bucyrus-Erie bulldozers
- 1 Lorain "75" 1½-yd. dragline
- 2 Allis-Chalmers Farmall tractors with tandem sheep-foot rollers

Minnesota Rural Highways Show Wide Traffic Range

Some rural roads in Minnesota carry traffic far above, and some far below, their class, it is indicated by the traffic counts made by the Highway Planning Survey. Generally the state trunk highways carry the heaviest traffic, county roads the medium traffic and township roads the lightest traffic, but there are some exceptions. On each road system there was found to be a wide range between the lightest and the heaviest traffic routes.

Traffic on the state trunk highways ranged from less than 25 vehicles per day on some few sections to more than 6,000 per day at other places. Average daily traffic on the original or constitutional trunk highways was 740 vehicles per day, but there were 78 miles carrying less than 100 vehicles per day. On the new or legislative routes added to the system in 1933, average daily traffic was 232 vehicles, but there were 17 miles carrying less than 25 vehicles per day, 148 miles carrying from 25 to 49 vehicles per day, and 496 miles carrying from 50 to 99 vehicles per day, a total of 661 miles carrying less than 100 vehicles per day.

Traffic on county roads ranged from less than 10 per day to more than 5,000 per day. County roads are of two main classes, state aid and county aid. State aid roads averaged 100 vehicles per day, but there were 115 miles which carried less than 10 vehicles per day and 675 miles carrying 10 to 24 vehicles per day. At the other extreme there were 31 miles of state aid roads carrying more than 1,000 vehicles per day, the highest carrying more than 5,000 per day. County aid roads carried an average daily traffic of 43 vehicles per day, but there were 1,690 miles carrying less than 10 vehicles per day, and there were 25 miles carrying more than 500 per day.

Average daily traffic on township roads was 13 vehicles per day. More than half the township roads carried less than 10 vehicles per day, and 98 per cent of them carried less than 50 vehicles per day. There were, however, 1,145 miles carrying 50 to 99 vehicles per day, 153 miles carrying 100 to 500 per day, and two short stretches carrying more than 800 vehicles per day.

Only roads outside city and village limits are included in this survey. The traffic figures are annual daily averages.

Asphalt Production Increases in 1941

Monthly Petroleum Statements of the U. S. Bureau of Mines issued for 11 months of 1941, according to a compilation released by The Asphalt Institute, reveal that net refinery production of asphalt in the United States amounted to 7,649,000 tons,—a figure 21 per cent above the previous record high, attained in 1940. This 11-month total exceeds the entire record year of 1940 by more than a million tons.

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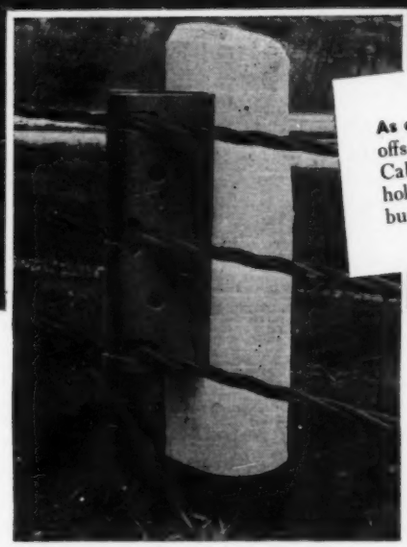

As an added safety feature, the offset brackets of Multisafty Cable Highway Guard have holes for installation of reflector buttons, if desired.

EVEN on a well-marked and well-engineered road, with poor driving or difficult driving conditions almost anything can happen. One good way to prevent accidents from becoming serious is to prevent cars that are out of control from leaving the highway. U·S·S Multisafty Cable Guard is a wise choice for this important job.

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Project Performance Record As Used in Idaho

By C. C. HALLVIK
Materials and Construction Engineer

ROADS are located, designed and constructed for the purpose of furnishing or improving facilities for the movement of vehicles from one point to another. A performance record of these improvements is something very necessary for future developments in the design of sections, treatment, and construction specifications. Due to the distribution of construction projects, the number of them constructed over a period of time, the details of design and construction of a project are only too soon forgotten by administrative personnel other than those immediately associated with the particular project. To assist in keeping an accessible, easily comprehensible general picture of a construction project after completion, Idaho has developed and is now using the Performance Record herewith shown.

The Materials Division at Idaho, with the advent in recent years of performing soils investigations and other material studies for the express purpose of proposing or recommending design and types of construction, felt the need for some simple performance record that in an instant will indicate the success or failure of the design or the materials used on projects already constructed. It has been our experience that in searching files for the records of some project, the data desirable was incomplete or not on record. This was particularly true concerning the sources of materials used in the construction. The record as now in use, which of course supplements the usual construction file, provides this information at a glance. Detailed information, will of course, still have to be obtained from the construction file which in recent years has been kept much more complete.

Changes in administrative personnel definitely retards progress in design and construction practices. New personnel, taking over a certain section of the state or in some administrative capacity at headquarters, can with little effort, peruse the project performance records to get a picture of what has been done in recent years, who constructed the projects, the materials used, design features and how the project is holding up. In this way, it is felt that a certain degree of continuity of ideas and advancement in design, materials and construction will result.

From the standpoint of design and the activities of the Materials Division, this record should be invaluable. Definite information will be available at a glance as to the success of the base provided, the type, grade and quantities of asphaltic materials used, the kind of cement used, etc. It will even reflect the quality of the work as to the engineering personnel in charge and the Contractor who constructed the project.

The Materials Division, having devised this form, also is responsible for the record. The form is filled out in duplicate immediately after the project has been completed by the representative of the Materials Division in each district, the District Materials Engineer. The original copy is sent to the Materials Laboratory and the duplicate is retained by the District Office. The form was designed to such size to readily fit into a standard stiff-backed ledger book with post binders.

After the form has been made out, it is then the duty of the District Materials Engineer to make an inspection of the project once a year and to note its condition. For simplicity, this is done graphically and by use of symbols. On the back of the sheet space is provided for notes that may be pertinent. Once a year the original copy at the laboratory is brought up to date to conform to the district copy so that persons at headquarters will have the same information available.

Though the record has been in use only for the past two years, it has already been referred to many times. It is believed, as the record becomes more complete and performance data noted up to five or ten years, much will be gained by the Idaho Highway Department in the matter of practical design, materials and construction problems.

Project Performance Record Instructions

The following instructions should be adhered to as closely as possible in making up the *"Project Performance Record"* form.

Number of Copies: The form shall be made up in duplicate, preferably on the typewriter, at the completion of every project. The *original* shall be forwarded to the *Materials Testing Laboratory,* Boise, Idaho, and the remaining copy retained for the District Office Record Book. Sheets shall be mailed in mailing tubes to prevent folds in the form.

Information Desired: The information desired on this form is the true, authentic data regarding the project reported. The data required under most items on the form is self-evident; however, the following instructions shall be followed as closely as possible:

Proj. No.: This shall contain only one project, not all the projects under one contract. In stage construction, the condition will arise where a project was graded and surfaced under, for instance, FAP 77 A(1) in 1938. This would be one sheet. Later, if oiled under FAP 77 A(2) in 1939, this will be a new sheet. A note will be made on FAP 77 A(1) to refer to FAP 77 A(2) and the project performance record will be kept on sheet covering FAP 77 A(2).

Sheet ... of ...: Should it be necessary, due to the length of the project and the scale used on the graph, to use more than one sheet for a project, the sheets should be numbered accordingly.

Location: Give in this space the highway number and the general local designation of the proper location.

Station ... to Station ...: State in this space the station limits of the sheet.

Inspectors: Names of the inspectors assigned to the major operations of the project; i.e., soils, surfacing, oiling, concrete, etc.

Date Construction Started: Report the actual date construction operations began on the project reported on the sheet.

Completion: The actual completion date of the project reported on the sheet.

Average Weather Conditions: State briefly the average weather conditions encountered during construction of the project reported; also, give a statement regarding temperatures.

Asphaltic Materials: Information requested is self-explanatory.

Concrete Materials: Information requested is self-explanatory.

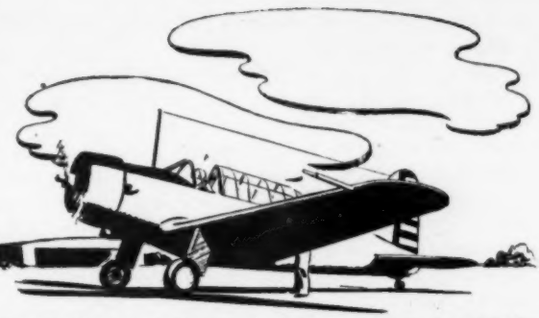
Traffic Data: Give brief statement as

EXTREMELY SATISFACTORY

"We are pleased to inform you that our experience with three new "99" Austin-Western power graders during 1941 was extremely satisfactory. These machines were used at Windsor Locks Airport, Connecticut, and at various Forts in Massachusetts. In all cases they handled excellently and were very low in maintenance cost.

"Any future grader purchases will certainly be from Austin-Western." Very truly yours,

John McCourt Co. and John P. Condon Corp.
By F. M. McCourt, President



STEAL A MARCH ON EVERY JOB YOU TACKLE

● Because of its exclusive features the "99-M" simplifies and speeds up all ordinary jobs of war and civilian construction and maintenance. Its powerful all-wheel drive, power-operated steer on all wheels, power blade shift, and effective neutralization of blade side-draft saves time and money on difficult jobs . . . making it possible to profitably handle narrow-margin contracts . . . utilizing budget dollars so they go a lot further and do a lot more work.

When the "99-M" is given an opportunity to demonstrate how its greater traction and more usable power steps up output . . . enables it to take over jobs formerly requiring several part-time machines . . . repeat orders automatically follow as additional equipment is needed. On one armament project alone, twenty-two fast-working "99-M's" are now teamed up . . . and are setting up a mammoth record of speed and accomplishment.

Investigate the "99-M" now. See for yourself how it helps steal a march on time and costs . . . on every job you tackle. THE AUSTIN-WESTERN ROAD MACHINERY CO., Aurora, Ill.

MOTOR GRADERS • ELEVATING GRADERS • SCRAPERS • CRUSHING AND SCREENING PLANTS
LOADERS • ROLLERS • ROLL-A-PLANES • MOTOR SWEEPERS • SHOVELS AND CRANES

to the amount and type of traffic.

Wearing Course: The wearing course is the pavement, oil mat, or surface treatment. Aggregate Type: report whether crushed gravel, screened gravel, crushed rock, or sand. Maximum Size: report specification requirement as to maximum size; i.e., 2 in., 1 in., ¾ in., etc. Source: report the pit or quarry number. Mixing Methods: report whether construction was plant mix, traveling plant, patrol mix, etc. Also note whether laying accomplished by machine or patrol.

Base Course: Refer to above.

Subbase: Refer to above.

Subgrade: If there is a soil profile made up for the project, report *yes*; if not, report *no*. If the project had a few samples taken at random, or spot sampled, report accordingly. Soil types; use PRA Classifications. Compaction; general specification requirements and how accomplished on project.

Construction Remarks: This space is provided to handle statements necessary relative to the construction of the project that may influence its performance and not mentioned elsewhere in the form. Such items as Contractor's cooperation, personnel, equipment, etc., should be noted. Items relative to borderline conditions in meeting specification requirements or enforcement difficulties must be noted.

Periodic Performance Data: The purpose of this part of the record is to give a graphical picture of the performance of the project. Once a year, preferably about spring break-up time, a survey of the project must be made and the information placed on the district copy of the sheet. Use the code letters as listed.

Date: Date condition survey was made. Should correspond to date under "Remarks" as provided on the back of the sheet.

Station ... to Station ...: Insert at this point the station limits covered by the graph immediately under.

Scale: It is desirable to standardize on scale 500′ to the inch, and 1000′ to the inch. The graph is divided into 11 1-inch units, further divided into tenths of an inch. At 500′ to the inch, each line will provide space for 1 mile; at 1000′ to the inch, each line will provide space for 2 miles, or in other words, a sheet will provide for a project 2 miles in length or 4 miles in length. For some projects it may be desirable to step up to a 2000′ to the inch scale in order to keep the project on one sheet.

Remarks: On the reverse side of the sheet, a space is provided for the date of the performance inspection and the name of the inspector. A brief statement as to the probable causes of any failures reported in the graph should be made. Also, a statement as to general project condition, such as surface, shoulders, ditches, slopes, drainage, etc., must be reported.

PROJECT PERFORMANCE RECORD

Proj. No. ..... : Sheet ..... of .....
Location .....
Station ..... to Station .....
Contractor .....
Res. Engr. ..... Inspectors .....
Date Construction Started ..... Completed .....
Average Weather Conditions .....

WEARING COURSE:
Seal: Aggregate, Type ..... Max. Size ..... Source .....
Ave. Oil per Sq. Yd. ..... gal.; Ave. Cover Sq. Yd. ..... lbs.
Pavement: Thickness ..... : Width ..... : Ave. % Oil Used .....
Aggregate, Type ..... Max. Size ..... Source .....
Mixing Methods .....
Prime: Width ..... ; Ave. Oil per Sq. Yd. ..... Gals.
BASE COURSE: Aggregate, Type ..... Max. Size ..... Source .....
Thickness ..... Placed in ..... courses.
SUBBASE: Aggregate, Type ..... Max. Size ..... Source .....
Thickness ..... Placed in ..... courses.
SUBGRADE: Soil Profiled ..... ; Spot Sampled .....
Predominant Soil Types Top 18" of Subgrade: Classification ..... Granular ..... Non-granular .....
Compaction Control on Project .....
CONSTRUCTION REMARKS: .....
BINDER .....
.....
Source .....
Cu. Yds. per Station:
Base .....
Subbase .....

ASPHALTIC MATERIALS

PRIME: Brand ..... Type ..... Grade .....
MIX: Brand ..... Type ..... Grade .....
SEAL: Brand ..... Type ..... Grade .....

CONCRETE MATERIALS

CEMENT: Brand ..... Type .....
AGGREGATE: Gravel Source ....
Sand Source ....
WATER: Source ....

TRAFFIC DATA: .....
.....
.....
.....

PERIODIC PERFORMANCE DATA

Code: A Excellent Condition
B Good or Fair Condition
C Failure of Wearing Surface
D Failure of Base or Subbase
E Failure of Subgrade (Settlements, Frost)
F Failure due to Slides, Floods, Etc.

Date | Station ..... To Station ..... Scale 1" = ... ft.

Date | Station ..... To Station ..... Scale 1" = ... ft.

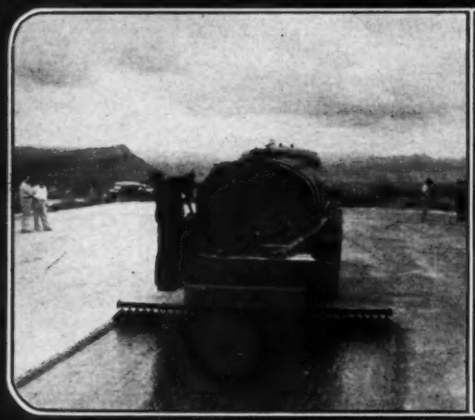
Front side of Project Performance Record. Actual size is 14 in. by 11 in.

REMARKS (See Instructions)

Date ..... Inspector ..... :

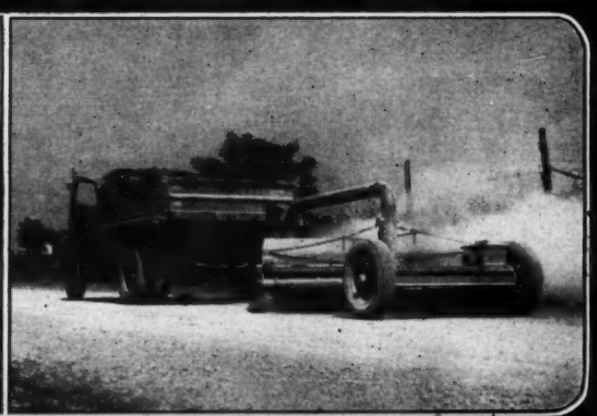
Back side of Project Performance Record

Speed Up Construction of "Defense Roads" with Littleford Equipment



Littleford "Spray Master" Pressure Distributors are the most efficient Tar and Asphalt Spraying Units made today. One valve stops and starts the spray—no gadgets, no valves to slow up the operator. Speed in construction is what we need today, and the "Spray Master" will give it. Send for details.

Littleford Supply Tanks haul the materials to the Distributors. No need to waste valuable time on vital roads when a Littleford Supply Tank can keep the Distributor going every hour of the day. Littleford Supply Tanks made by the new Frameless Construction Method saves you money. Write for further information on Littleford Frameless Construction Supply Tanks today.



The Trail-O-Roller is the Portable-Motorized Roller that can be taken to dozens of jobs in a single day. Trails behind any truck at any speed. Makes access roads permanent. We need roads open at all times, so "Keep Them Rolling" by rolling patches with a Trail-O-Roller. A rolled patch is in to stay.

Make roads' dust and dirt free before applying tar or asphalt by using a Littleford Power Driven or Traction Driven Road Broom. These Brooms help to make roads permanent. After sweeping, the applied materials penetrate the old road surface and adheres permanently. Littleford Road Brooms are the most modern units available. Perfectly balanced, sturdy construction.

BLACK TOP ROAD MAINTENANCE EQUIPMENT
LB
SINCE - 1900

LITTLEFORD

LITTLEFORD BROS., INC.
454 E. Pearl St., CINCINNATI, OHIO

Timber - Built Highway Bridge Conserves Steel

TIMBER construction of highway bridges, besides releasing urgently needed steel for war purposes, is producing sturdy structures speedily and at low cost. An especially fine demonstration of this may be seen in the new Crabbe Road Bridge across the North River near Tuscaloosa, Ala., recently opened to traffic by the county board of revenue.

The bridge, 333½ ft. long with a 24-ft. roadway, designed for an H-15 loading, cost $43,000 including the concrete piers—or $5.36 per square foot of roadway.

Designed by Donald A. du Plantier, Associate Professor of Structural Engineering, College of Engineering, University of Alabama, for fabrication by the Teco system of engineered timber construction, it was fabricated and erected by WPA labor under the direction of Powell Baker, WPA engineer.

The approaches are supported by trestles of 15-ft. span, six on the south side and four on the north, with 12-in. x 12-in. trestle caps. The channel span is composed of two identical pairs of 90-ft. span, half-through trusses, 15 ft. deep. End posts are 6-in. x 14-in.; chords, 6-in. x 12-in.; diagonals, 6-in. x 8-in., and verticals, 8-in. x 10-in. with the 10-inch dimension placed transverse to the bridge axis to stiffen the top chord for half-through construction. Joints are connected by Teco 4-in. shear plates and split rings, flat spiked grids and single curved spiked grids. Each main truss joint has four ⅜-in. steel gusset plates, two outer and two inner.

Trestle Approach to Crabbe Road Bridge

Underside of Bridge

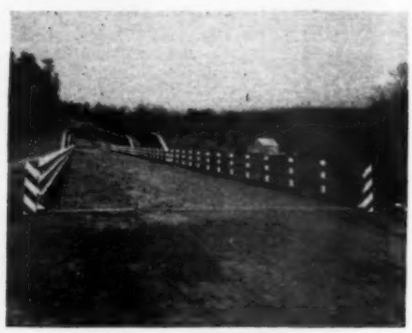
Floor trusses have 8-in. x 12-in. chords, 6-in. x 8-in. verticals, and 2-in. x 12-in. diagonals in pairs. Lateral bracing is of the "K" type with 3-in. x 8-in. timbers and steel gussets welded to the main gussets.

Stringers are 6-in. x 10-in, 15-ft. span, placed 30 in. on centers. Toenailed to the 4-in. x 10-in. subflooring is 2-in. x 2-in. laminated gum, surface flooring.

All timber was creosoted. In the piling, a 16-lb. full-cell treatment was employed and, for the other wood, an 8-lb. open cell treatment.

In designing the bridge Prof. du Plantier took advantage of the technical data and typical Teco designs offered to engineers by the Timber Engineering Co., Washington, D. C. He also had available the advisory services of the regional distributors of Teco Timber Connectors, Maxwell & Hitchcock, Atlanta, licensee of the Timber Engineering Co. of Georgia and Alabama.

Channel Span of Crabbe Road Bridge



Entrance to the Bridge

▼

World's Longest Lighted Highway.—What is stated to be the world's largest continuously lighted highway is the Queen Elizabeth Way in Ontario, Canada, extending from Toronto to Niagara Falls, a distance of 70 miles, with a further extension of 20 miles proposed to Fort Erie, opposite Buffalo, N. Y. This is a heavily travelled road through a thickly populated industrial area. It is well lighted throughout for night driving, making use of the silhouette principal instead of direct illumination.

▼

Motor Vehicle Registrations Increase in 1941.—Motor vehicle registrations are estimated to have increased 7.3 per cent during the year. The estimate includes 29,375,000 passenger cars, 68,000 busses, and 4,911,000 trucks. The figure for busses covers only 41 States, as in 7 States busses are not reported separately. State and Federal vehicles are not included in the estimate.

A WAR MESSAGE
to
ALL EMPLOYERS

★ From the United States Treasury Department ★

WINNING THIS WAR is going to take the mightiest effort America has ever made—in men, in materials, and in money! Every dollar, every dime that is not urgently needed for the civilian necessities of food, clothing, and shelter, must, if we are to secure final Victory, be put into the war effort.

An important part of the billions required to produce the planes, tanks, ships, and guns our Army and Navy need must come from the sale of Defense Bonds. Only by regular, week by week, pay-day by pay-day investment of the American people can this be done.

This is the American way to win. This is the way to preserve our democratic way of life.

Facing these facts, your Government needs, urgently, your cooperation with your employees in *immediately* enrolling them in a

PAY-ROLL SAVINGS PLAN

The Pay-Roll Savings Plan is simple and efficient. It provides, simply, for regular purchases by your employees of United States Defense Bonds through systematic—yet voluntary—pay-roll allotments. All you do is hold the total funds collected from these pay-roll allotments in a separate account and deliver a Defense Bond to the employee each time his allotments accumulate to an amount sufficient to purchase a Bond.

The Pay-Roll Savings Plan has the approval of the American Federation of Labor, the Congress for Industrial Organization, and the Railroad Brotherhoods. It is now in effect in several thousand companies varying in number of employees from 3 to over 10,000.

In sending the coupon below, you are under no obligation, other than your own interest in the future of your country, to install the Plan after you have given it your consideration. You will receive—1, a booklet describing how the Plan works; 2, samples of free literature furnished to companies installing the Plan; 3, a sample employee Pay-Roll Savings authorization card; and 4, the name of your State Defense Bond administrator who can supply experienced aid in setting up the Plan.

To get full facts, send the coupon below —today! Or write, Treasury Department, Section B, 709 Twelfth St., NW., Washington, D. C.

HOW THE PAY-ROLL SAVINGS PLAN HELPS YOUR COUNTRY

1. It provides immediate cash now to produce the finest, deadliest fighting equipment an Army and Navy ever needed to win.
2. It gives every American wage earner the opportunity for financial participation in National Defense.
3. By storing up wages, it will reduce the current demand for consumer goods while they are scarce, thus retarding inflation.
4. It reduces the percentage of Defense financing that must be placed with banks, thus putting our emergency financing on a sounder basis.
5. It builds a reserve buying power for the post-war purchase of civilian goods to keep our factories running after the war.
6. It helps your employees provide for their future.

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Washington, D. C.

We want to do our part. Please rush full information regarding the Pay-Roll Savings Plan.

NAME .....
POSITION .....
COMPANY NAME .....
ADDRESS .....
NUMBER OF EMPLOYEES .....

MAKE EVERY PAY-DAY . . . BOND DAY!

U. S. Defense BONDS ★ STAMPS

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GPO 16—25943-1 Form No. DSS-BP-2

EDITORIAL

Wanted! Two Alaska Highways by 1943

DURING our Civil War while army engineers were busy designing a bridge for a wide river crossing, the construction engineer who was to be in charge of its erection was called in by the general.

"Have your men and equipment ready to start work on the bridge a week from today."

"Yes, sir."

Six days later he was again summoned by the general.

"Are you ready to start tomorrow?"

"No, sir."

"What!"

"The bridge will be finished tonight."

It is that type of engineer who should be in charge of the proposed highway to Alaska. Under him others of the same type and experience should be in charge of the ten or more divisions into which the thousand miles of road should be divided.

While surveys are under way, and long before the final location has been made, construction roads should be started and construction camps built. This kind of work calls for superintendence by men who have had plenty of just that kind of experience in mountainous country. There, indeed, is where an eye for topography and a tongue like a whiplash will be needed. The engineer who depends on contour maps has no place there. Hand levels, rods, "flags" and aneroids should comprise his entire surveying equipment. No time should be lost in contour mapping, cross-sectioning and computation of yardage for the construction road. It should be speedily built mainly with power scrapers, bull-dozers and the like. It should be located on the best naturally drained ground available even though that necessitates its being often at a considerable distance from the projected, paved highway. Spur roads should run from the construction road to the projected highway. In short, a construction road that is to be a thousand miles or more long should be regarded as a pioneer road, built to expedite delivery of construction equipment and materials, without much regard to ton-mile costs of haulage. Therefore it differs as radically in its purpose as it does in its location and design from a permanent highway. Because it is "rough and ready" in appearance, let it not be inferred that such a construction road can be located and built well by a tyro.

There is wide difference of opinion as to the best location of the highway to Alaska. Engineers who have studied the problem longest favor a route along the east side of the Coast Range; but there is strong support by others in favor of a route from Edmonton northwestward, which would make it a far inland route.

Considering what is at stake in wartime, as well as the advantages to be derived from two such widely separated routes, there should be no hesitating about building highways over both routes at once. The rivalry of construction gangs on the two routes would itself add not a little to the speed of construction. Ultimately, highways will be built along both routes. "Eventually; why not now?"

Design to Save

ENGINEERS are just as anxious to conserve critical materials in highway and airport design for improvements and facilities necessary to the war effort as is anyone else. Sometimes their thinking may not go far enough in this direction. To design just to get within a priority rating is not the proper approach. It seems to the writer that if any critical material can be reduced to a minimum or, better yet, eliminated that thinking in design should be extended to such saving.

Take for instance the case of distributed type reinforcing steel, dowel rods, tie bars, and expensive load transfer devices in concrete slabs. Pavements can be designed in which critical material is employed in negligible quantities (or eliminated entirely) without sacrifice of quality such that their cost would not be any more, and sometimes less, than designs employing considerable quantities of steel. We must save steel, therefore, the designer owes an obligation to the war effort to use as little as possible, even to eliminate it entirely.

Concrete pavement slabs may be constructed in two ways, with regard to steel:

1. With steel reinforcement so distributed as to hold any cracks together that might form; load, of coarse, being considered also.

2. Distributed type reinforcing could be eliminated entirely by the pavement slab being so jointed at predetermined locations as to control intermediate cracking.

By the second method highway, airport runway or parking slabs are designed to handle the necessary loads. Little or no critical material will be required and the designer will be fulfilling his obligation to the war effort by designing not so much from the viewpoint of getting within a priority rating for the project as from the viewpoint of saving critical material. Even though the design is for a project that has a priority, the design should still contain an irreducible minimum of critical material.

Vertical slabs, walls, piers, or columns likewise can and should be designed to save critical materials. The design may or may not be economic as measured by peace time conditions. It is the writer's opinion that we are not so much interested in the peace time economics of a design which includes critical materials as we are in the saving of those materials. If the redesign, eliminating critical material, is economical, so much the better.

Successful Road Builders' Convention

THOSE who attended the recent convention of the American Road Builders' Association will, it is believed, concur in the opinion that a distinct service was rendered to the Highway Industry. The War Production Board priorities meeting and following clinics which were held jointly with and as a part of the convention gave engineers, contractors, equipment dealers, and manufacturers an opportunity to get some first hand information on the functioning and the purposes of the War Production Board. While all individual questions could not be answered to the complete satisfaction of the questioners, the panel clinic and the priorities clinics certainly served to define the general trends of procedure for the accomplishment of our war objectives as related to production and construction.

There are many problems, varied in their attendant conditions and circumstances, which must be treated individually. Naturally these could not be discussed in such meetings. However, it is safe to say that time consumed at the convention was well spent and the convention successfully concluded a service to the highway field.

The less said about dragged out banquets, the better.

Instructions for Preparation of New Priority Application Form PD–1A*

PRIORITIES Regulation No. 3 provides that on and after March 1, 1942, all individual applications for preference ratings must be assigned on the new forms PD-1A and PD-3A. However, all preference rating certificates issued under the original procedure will remain in effect until the terms of any such certificate have been executed. The new PD-1A form has been simplified for the purpose of expediting the handling of these applications by both the War Production Board and the applicant. Whereas the original PD-1 form consisted of several printed pages of questions to be answered and a large number of forms to be handled, the new procedure (PD-1A) consists of an instruction sheet which explains the exact type of information required in substantiation of the application. This information is to be submitted in triplicate in such form as to correspond with the paragraph numbers on the instruction sheet. A blank page is included in the application for this purpose.

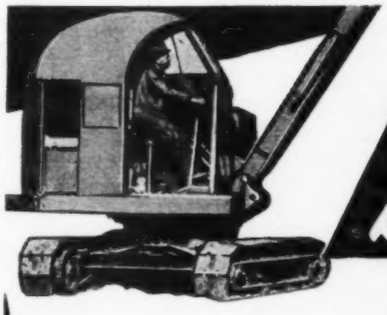
A separate application must be made for each class of Material (or Capital Equipment) commonly supplied by a single plant and for each Product or each use for which such Material (or Capital Equipment) is required. Form PD-1A may not be used to apply for a Preference Rating on requirements for plant expansion or plant construction, nor may it be used when adequate priority assistance is available under Priority Orders.

There follows the information required in submitting applications for preference ratings on form PD-1A.

To be answered on Form PD-1A by all applicants.

1. Describe Product to be produced by you from the Material (or Capital Equipment) for which application is made.
2. Explain relationship of Product produced by you to War Program, national welfare, or Government-sponsored programs.
3. If you have pending PD-1 or PD-1A application(s) for other Material required to fill the need for which this application is made, list for each such application (a) Description of Material, (b) Date of application.
4. a. If you are operating under any Preference Rating Order(s), "P" Series, applicable to the Product with respect to which this application is made, state Order Number(s) and Serial Number(s).
   b. If not, have you made application for any such Preference Rating Order(s), "P" Series? (Identify.)
   c. If you are operating under, or have applied for any such Preference Rating Order(s), "P" Series, explain why present application is made.

* (Supersedes Individual Preference Rating Form PD-1.



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ROLLED STEEL CONSTRUCTION
for GREATER STRENGTH and SPEED
BULLDOG GRIP

● There is tremendous closing power in Williams Buckets. That's why they bite so deeply and cleanly in hardpan digging, or work so proficiently in clearing rubble, lifting rocks or slabs of concrete.

Williams Buckets are "built to last and move dirt fast". All-welded construction at vital points imparts greater strength while eliminating excess weight; only riveted at sections which may ultimately require replacement. Another important exclusive feature of the Williams bucket, illustrated in action, is straight line reeving that reduces wear and prolongs cable life.

Many definite reasons why your next bucket should be a Williams are found in the individual bulletins completely describing each type of Williams Bucket. Sent free on request.

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SPEEDY
ACCURATE
DEPENDABLE
ECONOMICAL
CONVENIENT

★ Safety Treads on Platform, Steps and Running Boards
★ Double Cut-off Valves
★ Double Filters
★ "Pressure-Release" Manhole Cover
★ Fuel Tanks remotely located from Burners and Engine
★ 3" Tank Overflow
★ Electric Starter for Engine
★ Operator's Platform with Guard Rail
★ Hand Rails on both sides of Tank
★ Enclosed Intake Pipe Connection
★ Fool-proof Valves
★ Reinforced Tank
★ Burners operate at lower pressure
★ No Pipe Fittings in Circulating System

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503 DAVENPORT ROAD

Brooks EQUIPMENT & MFG. CO. KNOXVILLE, TENNESSEE

5. If Material is required for a single Government contract or a single civilian order for the Product, state:
   a. Name of Government agency or civilian customer.
   b. Supply Arm or Bureau (if Government agency).
   c. Complete Contract Number (if Government agency) or Purchase Order Number (if civilian).
   d. Quantity of Product on contract or on purchase order.
   e. Grade of preference rating (if any) assigned to Product on contract or on purchase order.
6. If material is required for several Government contracts or several civilian purchase orders for the Product, state:
   a. Names of all Government agencies whose contracts are held.
   b. Names of principal civilian customers whose purchase orders are held.
   c. Grade(s) of Preference Rating (if any) assigned to Product on contract(s) or on purchase order(s).
7. State with respect to each item for which Preference Rating is requested:
   a. The shipping date(s) promised by Supplier in the absence of a Preference Rating.
   b. Names of Suppliers (if any) who have refused to accept Applicants order.

To be answered on Form PD-1A only by applicants for preference rating on capital equipment.

8. a. State the following with respect to the department in which Capital Equipment is to be used:

	1st Shift	2d Shift	3d Shift
1. Number of men			
2. Average weekly hours worked			

   b. What percent of the total present output of the department referred to in 8a applied to Defense Orders?
   c. Do you have in use any equipment similar to that for which application is made?
   d. If so, what is the average weekly hours of use of equipment referred to in 8c.
   e. How do you now accomplish the work for which you require the equipment applied for?

Each statement in the application must bear the corresponding number as set forth on the instruction sheet.

The new forms, which are in triplicate, are to be completely filled out by the applicant. On the reverse side of the application is the "Preference Rating Certificate" which should also be filled out by the applicant with the exception of that space which is reserved for the approval of the Director of Industry Operations. In other words, the applicant now not only fills out his application but also the preference rating certificate which, after approval, will be returned to him. Only the duplicate copy should be signed by the applicant.

Differing from the original PD-1 procedure, preference rating certificate PD-1A can, within limitations, be assigned by the applicant by merely endorsing the following certification on the purchase order. Each new certificate has a serial number.

Certification

"Preference Rating ..... is hereby applied pursuant to Certificate PD-1A, Serial No.(s) ..... in accordance with Priorities Regulation No. 3, with which I certify I have complied.

(Address) .....

(Applicant, Supplier, or Subsupplier) .....

(Continued on page 81)

Organization of Construction Machinery Branch of War Production Board

RECENTLY there has been established within the Division of Industry Operations of the War Production Board, a Construction Machinery Branch, which consists of the following Sections:

Track-laying Tractor Section
Industrial Internal Combustion Engine Section
Excavating and Grading Machinery Section
Construction Equipment Section

The OPM Priorities Division has been absorbed by the Division of Industry Organization, which is headed by James S. Knowlson. Philip D. Reed is head of the bureau of Industry Branches, some 24 in number.

Function and Responsibilities

With respect to the industries and commodities listed above the Branch Chief works with the representatives of all divisions and bureaus of the War Production Board in the planning and scheduling of civilian and military production in furtherance of the Defense Program.

At this writing Mr. Andrew Stevenson is "Acting Chief" of the Construction Equipment Branch. Mr. Wm. M. Parrish, formerly with International Harvester Company of Chicago, is Assistant Chief. Eventually a chief will be appointed from outside of the industry (according to practice) to head the branch.

Such plans will include among others those for the collection, assembling and analysis of the necessary data on which all activities will be based; the determination of civilian, military, and Lend-Lease requirements; the assignment of priority ratings and handling of appeals therefrom; the expedition of materials to producers under assigned ratings; the conservation of strategic materials; the development of substitutes for strategic materials; the standardization of products; the establishing of the principle for schedule production; the shifting of quotas to allow for conversion; the conversion of plant facilities from civilian to defense production; and the provision of adequate labor.

The Construction Machinery Branch is set up in four sections to handle the work of the Branch. The products fall into principal groups as follows:

Track-laying Tractor Section

This Section will be concerned with all production problems affecting

RENEWABLE
TRACTOR WHEEL RIMS

Operators the country over are lowering costs and multiplying the life of their Caterpillar Tractor drive sprockets and idler wheels with renewable rims, pictured herewith. Simple instructions for laying out, trimming and welding are furnished with each shipment. Order today — or write for information.

Alloy Steel & Metals Co.
1862 E. 55TH ST. LAfayette 0181 LOS ANGELES, CALIF.
Manufacturers of PACIFIC CRUSHING & SCREENING UNITS • PACIFIC SLUSHING SCRAPERS & SHEAVE BLOCKS • ALLOY-MANGANESE MILL LINERS & CRUSHER JAWS • PACIFIC ROCK BIT GRINDERS • HAND WINCHES • CRAWLER SHOES, TRACTOR RIMS and other Wearing Parts

Available for most models of CATERPILLAR TRACTORS

Made of wear-resisting MANGANESE STEEL

They're Easily Welded on... Last Longer... Cost Less

MICHIGAN mobile SHOVELS

deliver High Yardage at Low Cost

More productive time on the job, and high-speed operation without operator fatigue . . . Lowest maintenance costs because of advanced design and construction. . . 25 m. p.h. road speed cuts travel-time between locations. Quickly converts to Crane, Clam, Dragline or Trench Hoe.

Learn how MICHIGAN mobile SHOVELS could help make your jobs pay bigger dividends — write TODAY for Bulletin S.

MICHIGAN — America's Mobile Shovel-Crane Specialists

MICHIGAN POWER SHOVEL CO.

BENTON HARBOR MICHIGAN

Above is illustrated the effective application of three SAUERMAN Power Drag Scrapers, and one Slackline Cableway to a specific problem.

A 2 cu. yd. Slackline Cableway excavates raw gravel from bed of river to screening plant—operating span 800 ft.

A 1½ cu. yd. Scraper operates between the gravel plant and a concrete mixing plant, stockpiling 400 cu. yds. of washed gravel a day.

A 1 cu. yd. Scraper and ¾ cu. yd. Scraper handle stone and sand from an unloading trestle to two long storage piles. Average combined daily tonnage 550 cu. yds.

SAUERMAN efficiency means greater economy and higher PROFITS!

Now is the time to apply the efficiency of a SAUERMAN Machine to your long range material-handling jobs.

Operating effectively over spans from 100 to 1500 ft. and handling from 10 to 1000 cu. yds. per hour, SAUERMAN Power Drag Scrapers and Cableway Excavators are readily adaptable to varying digging conditions—are unequalled for economy of operation.

WRITE FOR CATALOG!

SAUERMAN BROS. Inc.

588 S. Clinton St. Chicago, Ill.

crawler tractors, angledozers, bulldozers, power control units.

The output of these machines represents about 30 per cent of the dollar volume of the entire construction equipment industry; as to material consumed, 42 per cent; and men employed, 40 per cent.

The present requirements of Army-Navy-Lend-Lease and essential civilian needs place this Section in a position of importance and absolute necessity; especially since the issuance of Order L-53 which controls the distribution of the End Products.

This Section could be considered also as the logical unit for administering a wheel-type industrial tractor program. This is urgently needed to supplement the military requirements for cranes, etc.

Industrial Internal Combustion Engine Section

The primary purpose of this unit will be to obtain production to meet the military, Lend-Lease and export demands. This is tentatively set at 300,000 units for 1942, or an increase of possibly 30 per cent over 1941 production. This figure is based on needs of the construction industry only; the Automotive and Marine Propulsion field being excluded.

The contract with approximately 100 diesel and gasoline engine manufacturers will result in simplification of models, reallocations of orders, and conversion of certain facilities according to this general directive order. Standardization, conservation of critical materials and an intelligent and helpful supervision will be accomplished by this Section.

Excavating and Grading Machinery Section

This unit will deal with the problems relative to some 250 manufacturers of such equipment as heavy power cranes and shovels, ditching machines, motor graders, road rollers, carrying and hauling scrapers and other similar equipment.

Construction Machinery Section

This section will deal with the problems relative to approximately another 250 manufacturers of such equipment as asphalt plants, bituminous and concrete material, handling and finishing machinery, rock crushers, concrete pumps, contractors pumps, washing and screening plants and other similar equipment.

Consolidation

Up to the present time these two sections have been operating as a single unit planning a program that will utilize the facilities of the construction equipment industry most effectively in the war effort. This program is based on a knowledge of the requirements of the services for normal products; a knowledge of the facilities of the industry; and a plan to get all of these facilities producing war products which are either standard or special products as the requirements are shown to be.

Group A, under the direction of Paul Newton, formerly with the Austin-Western Road Machinery Co., Aurora, Ill., *deals with all equipment commonly used to prepare earth for a project.* Under this classification fall blade bits, crane, derrick, shovel and trencher booms, paving breakers, rotary brooms, clamshell, shovel, orange-peel and dragline scraper buckets; portable air compressors, crawler cranes, bucket, vertical, ladder and wheel ditchers; draglines, earth and rock-drilling machinery and drills, derricks, road discs, dredges and dredge equipment, earth-boring machines, pull-type blade, elevating, motor or self-propelled and under-truck type graders; grapples, jack and pile hammers, road-and-shoulder maintainers, snow and cable-laying plows, rippers and rooters, pneumatic-tired, tandem, three-wheel and tamping rollers; carrying

and hauling, drag, fresno, rotary and self-propelled scrapers; crawler, skimmer-scoop and trench-hoe power shovels.

In charge of Group B, *equipment used for completing the project*, is Tom McNutt, formerly with the J. D. Adams Co., Indianapolis, Ind. This group includes batching plants, both batchers and construction bins; concrete buckets, concrete buggies and carts, burners and torches, centerline marking equipment, concrete handling chutes, belt, bucket, screw and air-activated conveyors; asphalt, cone, gyratory, jaw, roll and impact crushers, pulverizers and spreaders; non-stationary crushing and screening plants, bituminous, bituminous-maintainer unit, bituminous-applicator unit and water distributors; aggregate dryers, bucket elevators, apron-and-pan, belt, drag, plate and roll feeders; joint and crack filling machines, fine graders, bituminous and concrete finishers, concrete and road forms, form tamping machines, asphalt surface, concrete, salamander, tank car, asphalt tool and water heaters; non-tractor mounted power hoists and winches, material receiving and charging hoppers, mud jacks, asphalt and tar, compound and roofer kettles; portable loaders for snow and material other than coal, agitating and truck, building, bituminous, bituminous paving, concrete paving and plaster mixers; fixed and portable asphalt plants, traveling asphalt stabilization plants, concrete and contractors' dewatering and supply pumps, gravity, rotary and vibrating screens; emulsion and cutback sprayers, controlled-feed, centrifugal and gravity material spreaders; concrete floor finishing surfacing machines, bituminous supply, water-sprinkler and water-supply portable tanks, concrete and placing and material elevating towers, concrete vibrators and portable washing and screening plants.

All of this equipment is useful and necessary to the war effort in varying degrees. It is required for the construction of airports, cantonments, camps, access roads, strategic roads, power dams, water-supply systems, canals, railroads, defense manufacturing plants, defense housing projects and other defense projects. In addition, several of the machines manufactured in the industry are definitely established as part of the mechanized and motorized military organizations. The problem of the construction machinery branch of the WPB is, therefore, not only to aid in supplying essential civilian requirements but also to expedite the production of military requirements. Companies from which men have been drafted by the Construction Machinery Branch, besides the three above-mentioned, include Barber-Greene, Bucyrus-Erie, Buckeye Traction Ditcher, Heil, Koehring, R. G. Le Tourneau and others.

With regard to the two other groups, Crawler Tractor group is headed by Mr. Mohler and the Industrial Engine group by Mr. Cherry.

Application Form PD-1A

(Continued from page 78)

(Date) .....
(Signature and title of Official) .....

Under the new procedure the applicant is not required to name the supplier but can extend the rating assigned him to any supplier who in turn can assign a rating to a subsupplier. There are several restrictions as to the extendability of these ratings, the most general one being that the rating cannot be extended unless the materials will be physically incorporated into material to be ultimately delivered to the original recipient of the preference rating.

CONTINENTAL MOTORS
Powering the Nation
AMERICA'S STANDARD
On countless jobs throughout America, Dependable Continental Red Seal Engines are on the job . . . supplying power efficiently and economically
BUFFALO SPRINGFIELD
Buffalo-Springfield 9-14 ton three axle tandem roller . . . powered by Continental F226 engine
Continental Motors Corporation
MUSKEGON, MICHIGAN

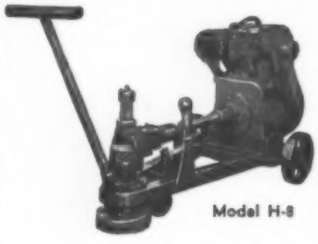
"FILLING IN"
as well as "DIGGING OUT"

is often an important task assigned to a bucket.
The inherent ability of OWEN buckets to consistently obtain capacity grabs in all kinds of material, plus the rapid dumping action as a result of special shell curvatures, makes such a job as is pictured here literally "duck soup" for an Owen.

THE OWEN BUCKET COMPANY • 6070 Breakwater Ave., Cleveland, O.
BRANCHES: New York, Philadelphia, Chicago, Berkeley, Calif.

OWEN BUCKETS GET A MOUTHFUL AT EVERY BITE

"BERG" HI-WAY SURFACERS

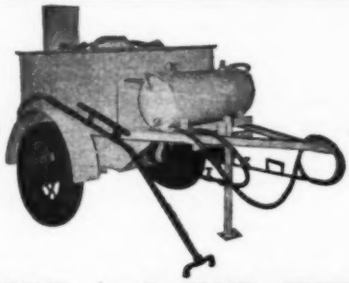


Model H-8

The model illustrated, is a one-man, gasoline driven machine, for surfacing concrete roads, streets, floors and other concrete paving.
The Power Take-Off is an EXCLUSIVE FEATURE, permitting attachment of "BERG" Flexible Shaft Equipment for surfacing walls, bridges, culverts, etc.

Write Dept. C

The Concrete Surfacing Machinery Co.
CINCINNATI, OHIO



ASPHALT and TAR KETTLES
FIRE PROOF—OIL BURNING
Hand and Motor driven spray.
Many sizes. Write for catalog.

Elkhart White Mfg. Co. Indiana

W. W. Polk Named Chief Highway Engineer of Illinois

Wesley W. Polk of Evanston, Ill., has been appointed chief highway engineer of the state of Illinois. The appointment fills the vacancy created by the resignation of Ernest Lieberman last September. Mr. Polk formerly was commissioner of public works, city engineer, and superintendent of the water department for the city of Evanston. He served as a lieutenant in the United States army engineer corps in the last war. From 1920 to 1926 he was employed as sanitary engineer for the Union Stock Yards and Transit Co. of Chicago. In the latter years he became superintendent of the Evanston Water Department and in 1937 he was given additional appointments as commissioner of public works and city engineer. He terminated his Evanston service last April. Mr. Polk is 49 years old, married, and lives at 715 Forest Ave., Evanston. He is a member of the Western Society of Engineers, the American Water Works Association, American Public Health Association and the American Road Builders Association. He is also a Mason and a member of the Evanston Chamber of Commerce, the Evanston Kiwanis Club, the University Club of Evanston, the Illinois St. Andrews society and the American Legion.

W. W. Polk

Maintenance and Repair Order Restricted

The following official interpretation has been issued by the Director of Industry Operations with respect to Preference Rating Order P-100, as amended:

"Paragraph (f) (1) of Preference Rating Order P-100 forbids application of the rating to obtain scarce material, the use of which could be eliminated without serious loss of efficiency by substitution of less scarce material or by change of design. Therefore, Governmental Units and other Producers engaged in repairing, maintaining or operating roads and highways may not apply the rating to obtain such items as metal culverts, metal road signs, metal rope or cable, metal guard rails, or metal reinforcing bars, since terra cotta, cement or wooden substitutes can be used for all these purposes, or their use can be entirely eliminated. The Preference Rating assigned by Preference Rating Order No. P-100 can in no circumstances be applied to deliveries of burlap or rubber for use in highway maintenance, repair or operation."

In Event Federal Automobile Stamp Lost or Stolen

Reports of lost or stolen federal motor vehicle use tax stamps have caused the United States Bureau of Internal Revenue to establish procedure to relieve motor vehicle owners of purchasing a second stamp if proof of original payment of the tax can be established.

It is important that motor vehicle owners fill out and mail to the Bureau of Internal Revenue the postal card supplied at the time use tax stamps are purchased. This will help establish proof of payment of the tax in the event of loss or theft of stamps.

Owners applying for relief in such cases will be required to submit an affidavit to the District Collector of Internal Revenue stating the date or approximate date on which the stamp was purchased, location of the post

office or Collector's office at which purchased, amount paid for stamp, make, model and serial number of vehicle from which stamp was lost or stolen, together with a concise statement of the facts and circumstances surrounding the theft or loss of the stamp.

If the information is satisfactory to the Collector, a statement will be given the owner which will be accepted by Federal officers as evidence that use tax has been paid on the vehicle described for the period indicated, but lost or stolen stamps will not be replaced free of charge.

New Method for Fixing No-Passing Zone Limits

A new method of determining the passing zone limits has been employed successfully in Highway Division IV of the State Highway Department of California. The method, which uses two automobiles with trailing wheels, is described in a recent issue of *California Highways and Public Works*.

In experimental tests, two cars were used to travel along the road and mark the limits of no-passing zones. Every physical condition existing at each location was studied, including the combination of horizontal and vertical curvature, which might affect the limits of a zone; structures, trees or cut banks which might have a bearing on sight distance, and any other combination of circumstances that could cause a difference in driver reaction.

Speed checks were taken at representative points on each route and section where there was an apparent need for the zone. These checks were so spaced as to provide a good average for each area where geographical and topographical conditions were consistent for a reasonable distance on either side of the checked points.

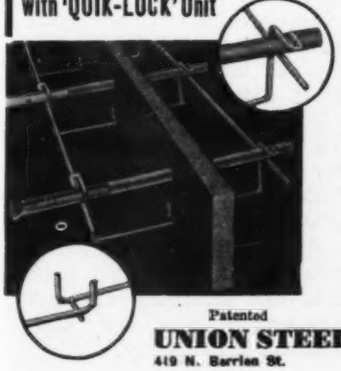
After reaching the decision on methods to be employed, it was necessary to work out the details of maintaining a predetermined distance between the two cars. A trailing wheel that measured in feet rather than miles and which could be readily mounted on the rear bumper of any car, was designed and the experiment was ready for trial. One wheel was required for each car.

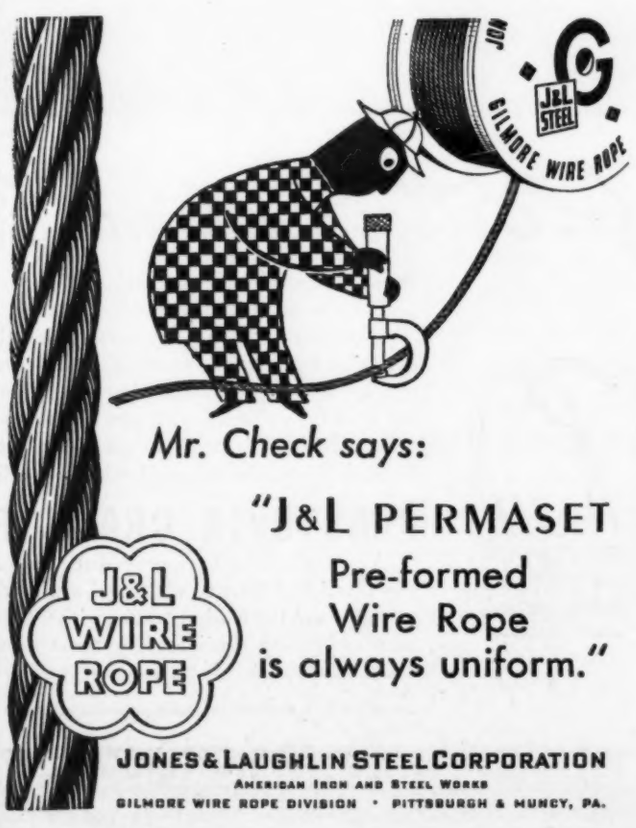
The next problem was communication between the two cars. The most satisfactory method would be via short wave radio telephone, but the difficulty of obtaining the necessary equipment and licenses on short notice dictated other methods. A public address unit was installed in the trunk of the leading car and a frame built to support the trunk door at a height that provided vision through the rear window with no screening of the speakers.

This method was used for the first few days but proved unsatisfactory due to noises from other traffic on the road that drowned out the system. A red spot lamp was installed in the rear window of the lead car connected to a button on the steering wheel and this was used for the balance of the work, with the public address system used to direct traffic which attempted to travel between the cars.

Personnel consisted of three men, one in the leading car and two in the trailing car. The actual marking was first done by the second man in the rear car with paint brushes mounted on 4-foot lengths of bamboo and two small cans of paint, one white the other yellow, mounted on the running board. However, the drip from the brushes whipped by the wind made a

"FLEX-PLANE"
Finishing Machines
and
Joint Installing Machines
FLEXIBLE ROAD JOINT MACHINE CO.
WARREN, OHIO

EXPANSION JOINTS MADE EASY
with 'QUIK-LOCK' Unit

This Union Road Dowel and Joint Assembly Unit assures lower cost, simplified installation, and fool-proof, trouble-free functioning.
Dowels are accurately positioned and locked parallel to each other and to the subgrade.
Write for Catalog of Construction Accessories
SEE OUR CATALOG IN SWEET'S
Patented
UNION STEEL PRODUCTS CO.
419 N. Berrien St. Albion, Mich.



Mr. Check says:
"J&L PERMASET
Pre-formed
Wire Rope
is always uniform."
J&L WIRE ROPE
JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
GILMORE WIRE ROPE DIVISION · PITTSBURGH & MUNCY, PA.

mess of the rear fender which was difficult to remove after the day's run and a change was made to oil cans with 6-inch spouts.

The marker in the rear car sat in the front seat and opened the door slightly, leaned down and squirted a small amount of paint on the pavement near the edge. It is intended for future work to mount two pump oil cans on the rear bumper with flexible tube and piano wire controls so that one man in the rear car can handle the entire job.

The actual procedure of locating zones consisted of starting approximately 2,500 feet in advance of the first point of restriction, where the equipment was mounted and a determination made from the previously taken speed checks as to the sight distance required for the speed of travel on that section. A speed of travel would then be agreed upon—20, 25, or 30 MPH depending on the alignment and expected frequency of the points of restriction.

The lead car pulled ahead the required distance and set to zero on the footmeter. The cars being the required distance apart the starting signal was given and both cars moved out accelerating as rapidly as comfortable to the agreed speed.

Check flashes were given with the spotlight at each 100 feet for the first 500 feet and each 500 feet thereafter until the end of the section was reached whereupon the rear car closed up on the front car and a check was made to be sure that wheel bounce or some weaving in the driving had not changed the relationship of the two instruments particularly at the higher speeds.

In practically all instances the difference was so minor that it could be disregarded. In two cases, however, the surface was rough and the disparity was sufficient to warrant a re-run at lower speeds.

After reaching the end of a section or a series of restricted locations the same procedure was followed in the opposite direction and all points marked in like manner.

The next step was to consolidate the markings on the pavement and place a visual indication for the stripping crew to follow. After running the section in both directions the trailing car started back and placed an arrow on either side of the existing single line at the beginning of the restriction in the colors to be painted in the respective positions, then at the points of change from one side to the other and finally at the end. The lead car during this time proceeded to the nearest culvert marker and starting from that known point logged the consolidated markings for a permanent record and for a check sheet for the striping crew.

Due to the magnitude of the work only the routes of reasonably heavy travel were marked. The light traveled routes will be run during the season when striping is not in progress and the zones will be marked next spring when repainting begins.

To facilitate rapid painting of the zones, the paint striping outfit was revised by adding a tank on the truck for yellow paint and by the addition of quick change valves on the striper to allow for changing color of one or more lines on the move.

After experiment it was found more rapid to paint the single line throughout an entire section skipping the "No-passing Zones" and then to change the guns on the striper and paint the zones on the return trip. This was primarily because of the method employed in California where a single stripe is 4 inches in width and the double stripe is 9 inches in width consisting of three 3-inch lines, the center line consisting of black lacquer to provide an extreme contrast for additional visibility.

for Better Roads and Streets

● BITUVIA road tar construction offers distinct advantages to both contractor and public. BITUVIA is easily applied, and its deep penetration holds the aggregate firmly for long service, assuring construction and maintenance economies. The highly resilient and skid-resistant BITUVIA surface contributes substantially to traffic safety. BITUVIA is made in seven types to meet any Federal, State, County or Municipal specification.

Reilly COAL TAR PRODUCTS

PLASTUVIA CRACK FILLER

Years of service have proved the unusual ability of this plasticised filler to withstand a wide range of temperature and the hardest traffic, without "pull" in summer or chipping in winter. PLASTUVIA is easily applied, and holds tenaciously to concrete and brick surfaces.

Complete information on these products will be sent on request.

REILLY TAR & CHEMICAL CORPORATION

Executive Offices Merchants Bank Building, Indianapolis, Indiana

2513 S. DAMEN AVENUE, CHICAGO, ILLINOIS 500 FIFTH AVENUE, NEW YORK, N. Y. ST. LOUIS PARK, MINNEAPOLIS, MINN.

SEVENTEEN · PLANTS · TO · SERVE · YOU

New Equipment and Materials

New Centrifugal Pump

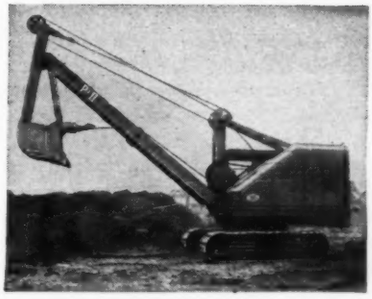
Chain Belt Co., 1600 West Bruce St., Milwaukee, Wis., has announced the manufacture of "Rex Junior," a light-weight, 3000 G.P.H. centrifugal pump weighing only 57 lbs. This 1½-in. pump contains all the engineering features of the standard line of Rex centrifugal pumps, including the patented Rex "peeler." It has a large semi-steel recirculating water chamber and is powered by a dependable, easy starting single cylinder, air cooled engine of 1 H.P. The engine is equipped with an automatic governor that speeds up the motor when the pump catches its prime and starts to lift water. This rugged little 3M water mover was designed mainly for the

Rex Junior Pump

contractor to pump water from excavations and to keep seepage levels low on bridge jobs, etc. The overall dimensions are 15¼ in. long by 11¾ in. wide by 15¾ in. high.

New 1½ Yd. Trench Hoe

A new trench hoe, stated to incorporate many refinements of design, has been brought out by the Harnischfeger Corporation, Milwaukee, Wis. Fast digging with great ease is accomplished by newly developed and powerful gear-driven booster device with positive primary chain drive. This auxiliary drum unit also speeds dipper reversing action and provides greater smoothness and accuracy in controlling the dipper. The 655-A is equipped with a 1½-yd. struck measure dipper. Its digging depth is 22 ft., it has a 37-ft. reach and a dumping height of 16 ft. A low pressure hydraulic system of the same type so successfully employed in the automotive industry, is used to control the

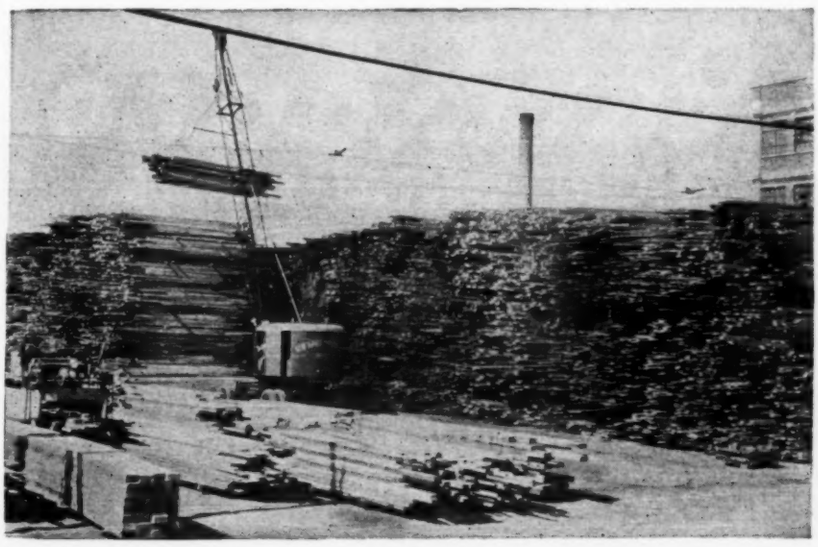


The 655-A Trench Hoe

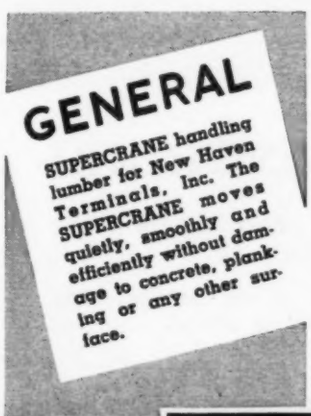
655-A. This new trench hoe is of all-welded alloy steel construction throughout.

New 3½S Mixer

A new 3½S non-tilting mixer has been brought out by Chain Belt Co., 1600 West Bruce St., Milwaukee, Wis. It has a 6-in. lower shoveling height; it has a self-cleaning hopper with no hopper gate to jam with aggregates or cement; it has a sure shimmy hopper control; it has die formed pressed steel drum heads with die formed pressed steel polished drum tracks, and it has a Rex chain belt drive. The



MOVE MORE, FASTER AND FOR LESS COST!


GENERAL
SUPERCRANE handling lumber for New Haven Terminals, Inc. The SUPERCRANE moves quietly, smoothly and efficiently without damage to concrete, planking or any other surface.

The GENERAL SUPERCRANE is a necessity on any job that requires more work per day, more speed on the job, and lower operating costs.

How can the GENERAL SUPERCRANE do all these things? It is self propelled—mounted on pneumatic tires — operated by one man—powered by one engine—and, well, why not send for new illustrated bulletin. It's free.

The OSGOOD COMPANY
Sizes: ½ to 2½ Cu. Yd.
Diesel - Oil - Gas - Electric
Associated with The GENERAL EXCAVATOR CO.

The HERCULES COMPANY
HERCULES "IRONEROLLERS"
6 to 12 Tons
Diesel or Gasoline
Associated with The GENERAL EXCAVATOR CO.

GENERAL
Sizes: ⅜-½-⅝-¾ Cu. Yd.
Diesel—Gas—Electric
SHOVELS
DRAGLINES - CRANES
Crawler & Wheel Mounted
THE GENERAL EXCAVATOR COMPANY, Marion, Ohio

The 3½S Skipper

3½S Skipper is an end discharge mixer mounted on two pneumatic tired wheels. It is equipped with a 3⅛ h.p. air cooled motor and can be furnished with or without water tank.

New Drifter

The D-505 drifter, the latest addition to the line of rock drills of Ingersoll-Rand Co., 11 Broadway, N. Y. C., incorporates many new and improved features, and is stated to be the fastest and most durable drifter ever produced by the company. Certain outstanding features contribute particularly to the ruggedness of the D-505. For example, the wall section of the fronthead is 10 percent thicker. The shank aligner is 18 percent longer and 8 percent thicker, and an improved chuck design of heavier construction has been included. The design of the piston-stem cushion bearing permits a heavier metal section in the cylinder and furnishes better support. There is a port on each side of the cylinder. The air to the front end of the cylinder passes directly between the ratchet and the

D-505 Drifter

head of the rifle bar. It is unrestricted by small ports. The D-505 employs a sturdy rifle bar which makes possible strong rotation. The rifle bar pawls are reversible for longer life. The throttle handle is more readily accessible, and is well protected by the backhead so that it cannot be broken easily.

New Truck Mixers

A complete line of 1942 Rex "Hi-Discharge" moto-mixers and moto-agitators has been announced by Chain Belt Co., 1600 West Bruce St., Milwaukee, Wis. These truck mixers are stated to have many revolutionary features. Primary among these features are rear charging, an improved mixing principle, and a high discharging point for greater spouting range. These mixing, charging and discharging methods are designed specifically for fast up-to-date mixing and transporting of high quality, low slump concrete. The Rex drum has one opening for both charging and discharging and uses that entire opening for both purposes—with no charging door to put on or off. There is a big wide rearcharging hopper which has a triple function. It serves as a receiving hopper for aggregates while charging, a stationary throw-back blade while mixing, and at the same time affords visibility or sampling of the batch. The Rex mixing principle makes the drum self-cleaning while mixing. Among other features is the completely enclosed anti-freeze water system, in which all water lines and

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HORIZONTAL DRILLS

Stop . . . AND THINK!

Parmanco Drills have convinced owners of their true value—

In the Coal field, the Iron range, the Utility and the Contracting field.

We build a model for every need.
Parmanco Drills are now in their fourth year of successful operations.

WRITE US YOUR DRILLING PROBLEMS

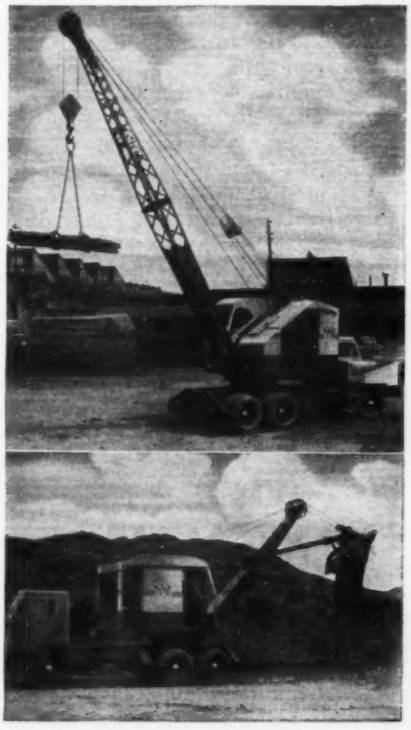
PARIS MANUFACTURING CO., INC.
PARIS, ILLINOIS

Rex Moto-Mixer

valves are protected by the heat of the motor against freezing. Another is the improved chain belt drive, and twin clutch transmission. Yet another is the man size inspection hatch with quick acting removable door.

New Transit Cranes

New 10 and 20-ton transit cranes have been brought out by Bucyrus-Erie Co., South Milwaukee, Wis. These cranes are not only fully convertible from crane to clamshell, dragline, shovel and dragshovel service, but are also designed for quick conversion from the wheel mounting to standard crawler mounting for occasional jobs inaccessible to wheel-mounted units. Speed and mobility to shorten non-productive traveling time and step up output are provided by the rugged, specially designed 10-wheeled mounting. Smaller of the two Bucyrus-Erie transit cranes is the 15-B, with a 10-ton maximum crane rating and convertible to ½-yd. excavator. The second unit is the 22-B which has a maximum crane rating of 20 tons and is convertible to a ¾-yd. clamshell, dragline, shovel or dragshovel. The Bucyrus-Erie wheel mounting provides an all-welded base. Tandem rear axles are mounted on an equalizer beam. Dual worm drive applies power and the rugged transmission provides 10 forward and 2 reverse speeds. Two identical engines are used, one for propelling, the other for handling hoist, swing, etc. Maximum speed on level ground is 27.5 m.p.h. for the 15-B and 31 m.p.h. for the 22-B. The 15-B is equipped with vacuum booster-set air brakes on all four rear wheels and the 22-B carries Westinghouse internal air brakes on the rear wheels. Service brakes on both models can be locked in engaged position; an additional cable-operated mechanical parking brake system is standard on both units. Revolving units of the transit cranes have the same features



New Bucyrus-Erie Transit Crane

as the standard 15-B and 22-B machines. Here are a few: full power-controlled boom operation through a boom hoist which is completely independent of all other functions; accurate control of swing and hoist through direct-action clutches which give the operator the "feel" of the load; full utilization of anti-friction bearings to gain maximum efficiency and minimize wear, and oil-enclosed gearing.

New Portable Searchlight Unit

Lister-Blackstone, Inc., Milwaukee, Wis., is now manufacturing powerful, portable searchlight units, in addition to its regular floodlight machines. Like the floodlight model, the searchlight model is called the "Nite-Hawk" and is a fully, self-contained source of light. It has a 24-in. searchlight with 3½ million candle power and throws an effective beam of light for one mile. Two 30,000 candle power wide-angle floodlights are also mounted for use as auxiliary or general lighting. If desired, more powerful searchlights may be used; with candle power up to 9,500,000 and effective lighting ranges up to three miles. The machine has many uses.

Milwaukee Journal Photo

New Portable Searchlight Unit

According to the manufacturer, its ability to throw a long, concentrated beam of light makes it useful for laying a stretch of pipe, for lighting the way for contractor's hauling units on cut and fill work or for general contractor's use on building work.

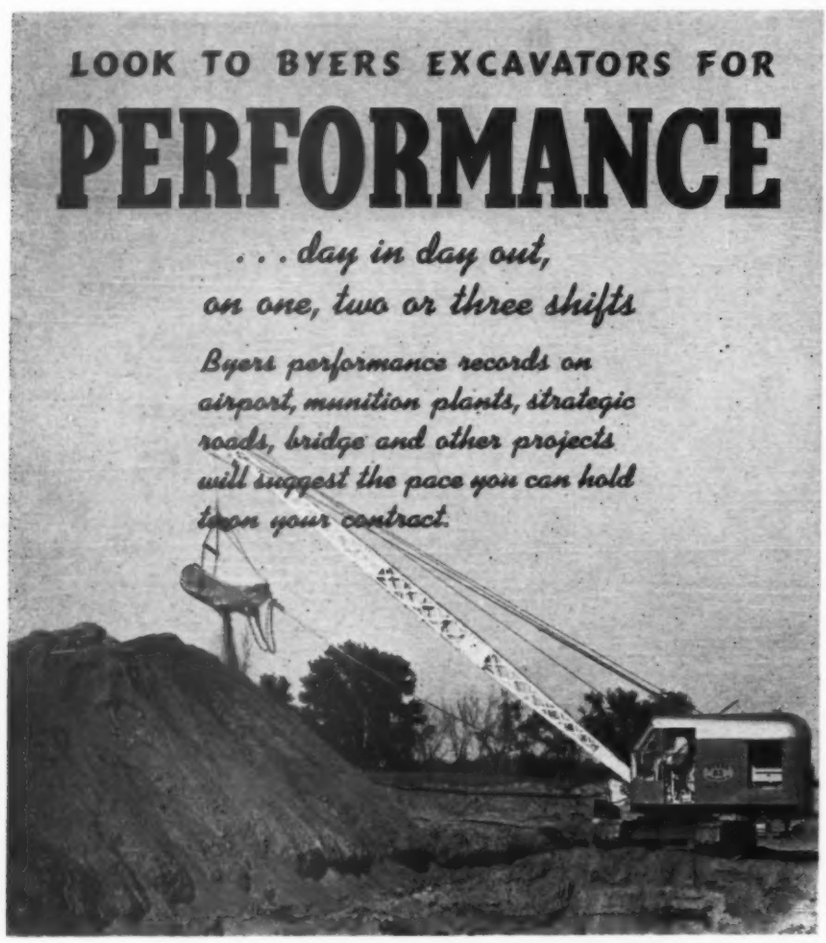
New Center Strip for Concrete Pavements

A new center strip for longitudinal and contraction joints in concrete highway and airport runway construction, fabricated from asphalt mastic board, has been announced by Keystone Asphalt Products Co., 43 E. Ohio St., Chicago. The product is offered in designs conforming to current standards, and is supplied in any required lengths and with desired punching for dowel pins and stake holes. It is not offered as a substitute for steel center strips, but as a product designed to serve the construction industry in longitudinal and contraction joints not only during, but also after "the duration." The center strip has a high tensile strength which facilitates handling on the job, and provides an entirely waterproof seal between the slabs. It will not rust or deteriorate after years of service.

WITH THE MANUFACTURERS

Pecaut Made Distributor for Chain Belt

Chain Belt Co., Milwaukee, Wis., has announced the appointment of Pecaut Industrial Supply Co., 1819 E. Fourth St,. Sioux City, Ia., as distributor of Rex construction machin-


LOOK TO BYERS EXCAVATORS FOR
PERFORMANCE
. . . day in day out,
on one, two or three shifts
Byers performance records on airport, munition plants, strategic roads, bridge and other projects will suggest the pace you can hold upon your contract.

SAVE TIME on dragline work with Byers independent travel feature! A Byers crane or dragline is always ready to move on its crawlers instantly . . . at the touch of a single lever . . . because flow of power is direct from motor to each working operation. (Byers excavators do NOT travel on their swinging mechanism.)

This time saving feature is another reason why you should investigate Byers cranes and dragline in sizes through ¾ yd.

Modern CRANES and SHOVELS

BYERS

RAVENNA, OHIO

ery in the Sioux City area. Stanley F. Pecaut is manager and he and his associates have had wide experience in the construction machinery industry and are well qualified to serve the construction trade. Pecaut Industrial Supply Co. maintains a warehouse at the above address with a stock of new model Rex mixers and Rex pumps which enables them to make quick delivery. This company also carries a complete line of industrial and mill supplies as well as contractors machinery.

Dave Buttles Promoted by Cummins Engine Co.

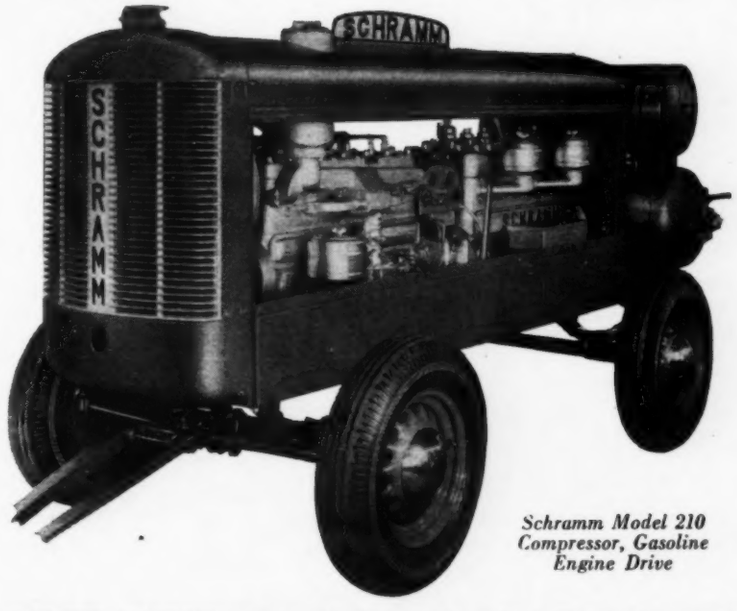
P. E. Letsinger, vice-president in charge of sales, Cummins Engine Co., has announced the appointment of D. J. Buttles as western manager with offices in the newly - established, direct factory branch at Salt Lake City. The eleven western states have always been one of the most important markets for Cummins Diesel engines. In addition to the Pacific Coast States, the territory includes British Columbia, Alaska and Hawaii. Under Mr. Buttles' management are three sales regions. In each of these is a sales representative. R. H. Wills is in charge of the Northwest Region; Tom Collins, the Southwest Region; and it is understood that a new man will be selected to cover the third region. The new man to be selected will make his office either at the branch in Salt Lake City, or the sub-branch in Denver. No announcement has yet been made of the local manager for Salt Lake City or Denver. Service in this territory will be handled by two of the best known and most competent men in Cummins' organization—Paul Phillips will work out of the Salt Lake branch covering the Northwest and Clyde Tatman, who for the last nine years has been associated with the Diesel Motor Sales and Service Co. of Los Angeles, will cover the Southwest.

D. J. Buttles

D. G. Sherwin of Caterpillar Tractor Co. Is Dead

Donald G. Sherwin, Vice-President and Director of Caterpillar Tractor Co., died Feb. 11 at his home in San Leandro, Calif., after several years of ill health. A native of Suffield, Conn., Mr. Sherwin was born in 1894. He was graduated from St. Lawrence University and Brooklyn Law School and admitted to the bar in New York State. After serving as a lieutenant in the United States Navy during World War I, Mr. Sherwin resumed law work briefly, then chose the field of finance, in which he achieved notable success. He first served with the Chase National Bank of New York, then moved to the Pacific Coast to become associated with the Anglo-California Trust Co. of San Francisco. From 1923 until 1933 he was connected with Peirce-Fair and Co., a San Francisco bond firm. He left his position as vice-president and director of that company to become a partner in the firm of Sherwin and Simpson, investment counselors. In 1934 he became a member of the "Caterpillar" organization and moved to Peoria, Ill. For several years he was vice-president and treasurer, later being given administrative direction of the advertising, sales and treasury departments. In January of 1939 he was made a member of the board of directors. Ill health necessitated his return to California in 1940 and his duties, since then, were to coordinate activities there with Peoria operations. Mr. Sherwin is survived by his wife Arline, and by two sons, Douglas Fenn, 24 and Proctor Austin, 12.

AIR FOR DEFENSE



Schramm Model 210 Compressor, Gasoline Engine Drive

A UNITED NATION puts its shoulder to the wheel. Every Community is organizing to further combat and protect its People from the "agencies of destruction".

The Contribution of SCHRAMM, INC. to this tremendous Defense Plan consists of combinations of compressed air power for operating air and fire sirens—tools for demolition and rescue work—repair work on gas and water mains—electric, telephone and telegraph lines and railroad maintenance.

SCHRAMM, INC. is prepared to furnish air compressors that apply to every emergency requiring "AIR FOR DEFENSE".

Built in Sizes 20 to 420 Cu. Ft. Actual Air Delivered

Write for Bulletin No. 4260

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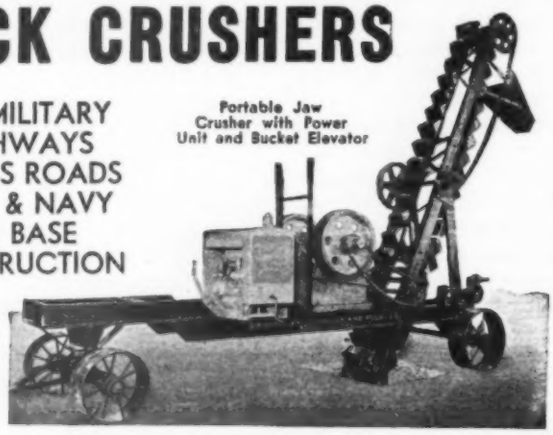
GRUENDLER'S FIFTY-SEVENTH YEAR

STATIONARY-PORTABLE *and* MOBILE

ROCK CRUSHERS

FOR MILITARY
HIGHWAYS
ACCESS ROADS
ARMY & NAVY
AIR BASE
CONSTRUCTION



Portable Jaw Crusher with Power Unit and Bucket Elevator

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WRITE TO US FOR NEW CATALOG NO. 601

★

Gruendler Portable Crushers

Proper Size Aggregates -- on the Job

Balanced. Non-Tipping. Expertly designed to meet your exact requirements in proper size aggregates—larger capacity and quick mobility to and from job.

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CONVEYORS

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Four Wheel Maintenance Jaw CRUSHER with Power Unit for easy mobility to and from the job.

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In the center of 3-acre park of tropical palms and flowers. Just off No. 1 Highway. Open throughout the year. All rooms with bath or showers $2.50 up. Special low weekly, monthly and season rates.

Surf bathing—boating—fishing—golfing—shuffleboard and other sports for your entertainment. Congenial atmosphere prevails at this attractive Spanish Inn.

Ownership Management—Write for booklet

AAA

New Trade Literature

Kotal.—A 16-page bulletin on the Kotal process for waterproofing aggregates for bituminous construction has been issued by the Kotal Co., 52 Vanderbilt Ave., New York, N. Y. It contains descriptions and numerous illustrations of the methods of using Kotal in bituminous mixes in highway and airport construction.

Scrapers, Bulldozers, Tampers, Etc.—A new complete equipment booklet describing the earthmoving, land clearing and snow removal equipment manufactured by the LaPlant-Choate Manufacturing Co., Inc. of Cedar Rapids, Ia., has just been released. Each model is described generally, with explanations as to size and capacity. The fact that all equipment is built exclusively for use with "Caterpillar" tractors is emphasized, as is their world wide sales and service organization. Sections are devoted to cable-operated scrapers, ranging in size from 12 to 33 cu. yd. to hydraulically operated scrapers of 3.8 to 8.2 yd., and the new CW-10 "Carrimor" 10 cu. yd. scraper. Trailbuilders, bulldozers, tampers, rippers and other tools are also included. The booklet is 16 pages in two colors, and may be obtained from the manufacturer.

Concrete Form-Tying Devices.—The Richmond Screw Anchor Co., Inc., manufacturers of prefabricated form-tying devices, 836 Liberty Ave., Brooklyn, N. Y., has issued an interesting 32-page booklet, devoted mainly to the organization of the company, its personnel and methods of designing and manufacturing its products. Included are numerous illustrations of the various form-tying devices made by the company.

"How Small Industries Can Go After War Work."—This is the title of an illustrated booklet published by the Copper & Brass Research Association. The purpose of the booklet is to show small companies how to go after contracts or subcontracts through the Contract Distribution Branch, Production Division, War Production Board, Washington, D. C., or through its Regional Offices in many cities in each state. The booklet contains information on how industry can secure loans for equipment to make war armament, how small companies can form pools to obtain contracts, and other helpful data. A list of Regional Offices and addresses, the names of officers and telephone numbers are included. A copy of the book can be obtained

without charge by writing to the Association at 420 Lexington Ave., New York, N. Y.

Soil Stabilization Equipment.—A 28-page catalog describing its equipment for soil stabilization has been issued by Allis-Chalmers. Printed in 2 colors the catalog illustrates, and describes the necessary tractors, graders, discs, harrows, sub-graders, mixers, water distributers, rollers and other equipment. Complete mechanical specifications are also provided. The book entitled, "Allis-Chalmers Equipment for Soil Stabilization," carries the Form No. MS-802 and is available without charge from Allis-Chalmers, Milwaukee, Wis.

Pumps.—A new catalog illustrating and describing its line of Rex centrifugal water pumps for 1942 has been issued by Chain Belt Co., Milwaukee, Wis. Rex speed prime pumps are made in capacities ranging from 3,000 g.p.h. to 125,000 g.p.h. Among the features found in these pumps are: positive prime control, Rex Z-metal impeller, Rex patented air peeler, Rex rotary seal, and replaceable liners. Included in the catalog are not only detailed information and specifications concerning the design and manufacture of these pumps, but also valuable data on how to pick a pump for a specific job.

Loaders.—The Athey MobiLoader is pictured and described in an interesting 12-page booklet just released by the Athey Truss Wheel Co., 5631 West 65th St., Chicago, Ill. This booklet, entitled "The Athey MobiLoader" shows many applications of both the W4 and the Model 8 loaders in action. Some of the jobs illustrated are mining, general excavation, snow clearing, stockpile work, loading beets, handling gravel and crushed stone. A new booklet is also available featuring the new Athey Force-Feed Loader. Copies will be sent upon request.

Early Strength Cements.—A new 64-page manual issued by the Calcium Chloride Association tells how to speed up year-round concreting, shows how to secure high early strength and greater workability at temperatures either below or above freezing. It gives latest data developed at the National Bureau of Standards on the effects of low temperatures and explains how to offset the retarding action of cold weather. The book contains authoritative research papers and many actual examples of practical concreting operations, and is well illustrated with more than sixty photos, charts, graphs and tables. Copies of this con-

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Stream diversion frequently requires a major operation, but in this installation GOHI Pipe solved the problem easily and permanently. The water is confined to its original course and a valuable building site preserved and safeguarded. Whatever your drainage problem, look to GOHI Pipe for the answer.

Consult the fabricator located nearest you, and ask for copy of 72-page book on modern drainage practice. It's FREE.

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Central Culvert Co.	Ottumwa, Iowa
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Bancroft & Martin Rolling Mills Co.	S. Portland, Me.
Denver Steel & Iron Works Co.	Denver, Colo.
The Lane Pipe Corporation	Bath, N. Y.
Dixie Culvert Mfg. Co.	Little Rock, Ark.
St. Paul Corrugating Co.	St. Paul, Minn.
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GOHI Pipe meets Copper-Bearing Pure Iron requirements in all specifications published by nationally recognized specifying authorities.

GOHI CULVERT MANUFACTURERS, INC.,
NEWPORT, KY.

creting handbook may be had without charge by asking for Bulletin No. 28. Address your request to Calcium Chloride Association, 4145 Penobscot Bldg., Detroit, Mich.

Expansion Joints and Water Seals.—Servicised Products Corporation, 6051 West 65th St., Chicago, Ill., has just completed a new catalog of compiled facts on expansion joints and water seals. Servicised has been in this field for over 22 years, and many types of expansion joints are listed in this catalog, copies of which can be had on request to the manufacturer.

Curing Concrete.—The Johnson-March Corporation, 52 Vanderbilt Ave., New York City, has issued an interesting circular illustrating and describing the curing of concrete with Ritecure.

Composite Construction.—An interesting circular dealing with composite construction has been issued by the Porete Mfg. Co., Porete Ave., North Arlington, N. J. This construction is a combination of structural steel beams carrying a reinforced concrete floor slab in which a steel spiral or other shear reinforcement is welded to the top flange of the steel beam and embedded in the concrete slab. The circular contains information and drawings on the strengthening of bridges and also examples of the use of composite design in bridge construction.

Portable Electric Tools.—The complete 1942 line of THOR Portable Electric Tools is described in an attractive new 64-page catalog just issued by the Independent Pneumatic Tool Company, 600 West Jackson Blvd., Chicago, Illinois. Containing four major sections, the book, known as Catalog No. 37, gives complete descriptions, specifications and prices on the entire THOR line of universal type electric drills, drill stands, screw drivers, nut setters, tappers, saws, hammers, nibblers, grinders, sanders, polishers and electric tool accessories. Featured in the new catalog are the ¼" and ½" capacity drills. Catalog No. 37 is available to industrial executives, production men and engineers upon request.

Cranes and Shovels.—The Osgood Company, Marion, Ohio, has released two new catalogs. Catalog 4128 illustrates and describes the new Osgood Mobilcrane built in three sizes. Bulletin 4132 features the Osgood Type 70 air control machines. Copies available on request.

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CRUSHING, SCREENING and WASHING UNITS
● Up to 2000 Tons a Day ●
Crushers, Elevators, Sweepers, Screens, Wash Boxes, Bins, Pulverizers, Feeders, Spreaders, Kettles, Conveyors, Drag-Lines, "GAYCO" Centrifugal Air Separators
UNIVERSAL ROAD MACHINERY CO.
Kingston, N. Y.
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For Complete Snow Removal
ELIMINATES dangerous one way bottlenecks. Reduces expensive repeat plowing. Reduces snow damage to roads, and cuts resulting road repair. Plan now for real snow removal next winter.
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DUBUQUE IOWA

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For Better Roads, put a WORKMAN Machine on the job. 3 sizes:
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THE MASTER
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UNADILLA, NEW YORK

NEED A BIG Trailer?
La Crosse Makes Them Up To 200 Ton Capacity
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VULCAN PAVEMENT AND CLAY DIGGING TOOLS
ARE MADE in a complete line of sizes to fit all standard compressed air hammers.
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VULCAN TOOL MFG. CO.
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CUT MOWING COSTS
With SILVER KING
Do fast, economical mowing on the level or in the rough with Silver King, the mowing unit that's ENGINEERED for the job. Write for details.
THE FATE-ROOT-HEATH CO.
Plymouth, Ohio
The Favorite Mowing Unit for City, County and State Highway Departments

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80 PAGE CATALOG
of modern portable oilburning equipment for the building, repair and maintenance of roads, airports, industrial plants, etc. Complete specifications, prices, shipping weights, illustrations, etc.
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REFLECTO PRODUCTS
New Luminous REFLECTO CHAIN
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Reflects With Light, Glows Without Light
Ideal for "Black-out" Signs
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"The Eyes of the Road"
Suggestions for your problems, no obligation.
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An all year round machine for cleaning slush and ice from roads during the winter months and for road and shoulder maintenance during the spring and summer.

Of modern design and improved control together with many other exclusive features make it a valuable addition to State and County equipment.

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Builders of Equipment for more than fifty years.

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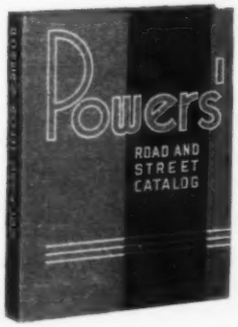


A Complete Catalog Service For the Buyer of Highway Equipment and Materials

Contains Specifications for Modern Equipment; Conversion and Quantity Tables; also, Specifications for Airport Construction.

Directory of Distributors gives nearest service point to job.

Powers' Road & Street Catalog

Published by

Gillette Publishing Company

330 So. Wells St., Chicago, Ill.

Power Grader.—An attractive 8-page bulletin, No. 1946, describing the Austin-Western 99-M power grader is now ready for distribution. In addition to the specifications and general description of mechanical features that ordinarily appear in a piece of this kind, bulletin 1946 describes the operating features of the machine both in text and illustration and shows how the theory behind the design of the unit has been developed to produce the highly desirable characteristics claimed for the machine. Copies may be secured by addressing your request to the manufacturers, The Austin-Western Road Machinery Co., Aurora, Illinois.

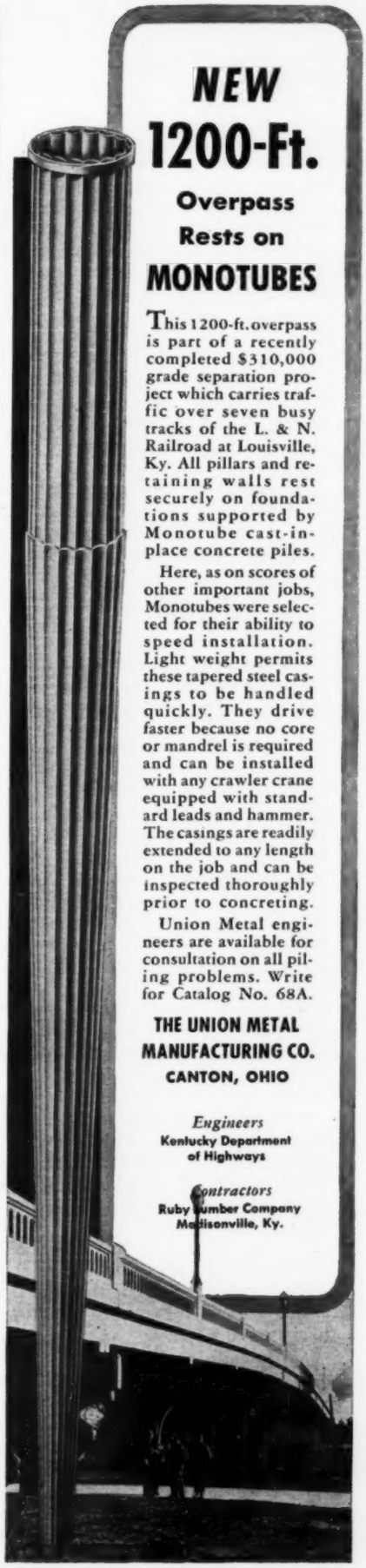
Paver.—Koehring Co., 3026 W. Concordia Ave., Milwaukee, Wisconsin, has recently released a catalog describing their new 34-F paver—a single drum unit with air controlled discharge chute. The new machine is well illustrated in the catalog which presents a description of the mixing action, the twin-door boom bucket and the other modern improvements incorporated in the paver's design.

Tar Kettle.—A new bulletin describing a portable tar kettle, a new product of Diamond Iron Works, Inc., Minneapolis, Minn., was issued recently. The bulletin fully illustrates and describes the new melting kettle and gives detailed dimensions and specifications. When writing the manufacturer for a copy of the bulletin be sure to mention this magazine.

National Defense.—A 32-page bulletin has been issued by International Harvester Company to "furnish employes, stockholders, dealers and the public a complete and connected story of International Harvester's part—up to now—in the arming of the United States." It is a pictorial presentation with emphasis on the military production rather than the normal production of the Company.

National Defense.—Some 34,000 road officials and contractors throughout this country have received copies of a booklet entitled "Our Part in National Defense," which has been distributed by The Galion Iron Works & Manufacturing Company, Galion, Ohio. It shows in a general way the part played in National Defense by each Galion unit.

Spreaders.—A new bulletin recently released by Good Roads Machinery Corporation, Kennett Square, Pa., describes a material spreader for which the manufacturer makes some interesting claims. Extreme accuracy of


NEW
1200-Ft.
Overpass
Rests on
MONOTUBES
This 1200-ft. overpass is part of a recently completed $310,000 grade separation project which carries traffic over seven busy tracks of the L. & N. Railroad at Louisville, Ky. All pillars and retaining walls rest securely on foundations supported by Monotube cast-in-place concrete piles.
Here, as on scores of other important jobs, Monotubes were selected for their ability to speed installation. Light weight permits these tapered steel casings to be handled quickly. They drive faster because no core or mandrel is required and can be installed with any crawler crane equipped with standard leads and hammer. The casings are readily extended to any length on the job and can be inspected thoroughly prior to concreting.
Union Metal engineers are available for consultation on all piling problems. Write for Catalog No. 68A.
THE UNION METAL MANUFACTURING CO.
CANTON, OHIO
Engineers
Kentucky Department of Highways
Contractors
Ruby Lumber Company
Madisonville, Ky.

control is one of the most important. The bulletin also emphasizes the number of gadgets the new unit can get along without because of its advanced design. If you want a copy ask for Bulletin 1879.

Snow Plows.—Their line of snow plows and other equipment for snow and ice control is described in Bulletin 1878 now being distributed by Good Roads Machinery Corporation, Kennett Square, Pa. This piece of literature might be described as a condensed catalog.

Crushing Plants.—Two types of sized stone plants are shown in a new bulletin received from the Iowa Manufacturing Company of Cedar Rapids, Iowa. Their line of stone crusher outfits, Models "SCO" include four sizes of jaw crushers, either plain or roller bearing, and as illustrated may be used with either vibrating or revolving screen. A diagram illustrates method of setting up the plant and shows drives, elevator, reject chute and compartment bin. The bulletin gives complete specifications. Copies of this two-color bulletin may be obtained from any dealer or by writing direct to the manufacturer.

Portable Washing Plant.—A small portable washing plant is illustrated and described in a single sheet specification bulletin issued by the Iowa Manufacturing Company of Cedar Rapids, Iowa. This addition to the line is built to handle small jobs that require washed aggregates. The bulletin gives complete details and specifications. Write to the manufacturer or any dealer for copies.

Screening Plant.—A new portable horizontal screening plant is well illustrated and described in a two-color single sheet bulletin just received from the Iowa Manufacturing Company, Cedar Rapids, Iowa. The many special features of this plant are clearly shown in the bulletin and specifications of the plant are listed. Copies of the bulletin are available on request.

Crushing Plant.—The portable crushing plant of the Iowa Manufacturing Company, Cedar Rapids, Iowa, is described in a new, two-color single sheet bulletin. Action photos of two models show various combinations of conveyors and elevators. The operation of the plant is described and a diagram shows the flow of material through the equipment. Complete specifications of Models 10-18 and 10-22 are given. Copies of this bulletin may be obtained from the manufacturer.

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USED EQUIPMENT BARGAINS

We are liquidating several large modern contracting outfits. Write or wire us for price and description on any item you need, or for complete lists. Equipment for sale includes:

Tractors—all sizes
Scrapers—4 to 20 yards
Rooters—Heavy Duty
Compressors—Gas & Diesel
Concrete Mixers
Self-priming Pumps
Power Units—Gas & Diesel
Crushing & Screening Plants
Stone Chip Spreaders
Tank Car Heaters
Road Oil & Asphalt Heaters
Road Rollers
Sheep's Foot Rollers
Elevating Graders
Motor & Blade Graders
Power Driven Road Brooms

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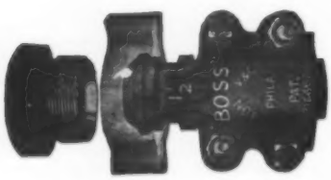

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for 6 x 19 Seale Construction	34 times diameter of rope
for 6 x 16 Filler Wire Construction	30 times diameter of rope
for Flattened Strand (Type B & G)	30 times diameter of rope
for 8 x 19 Seale Construction	26 times diameter of rope
for 6 x 19 Filler Wire	26 times diameter of rope
for 6 x 22 Filler Wire	23 times diameter of rope
for 8 x 19 Warrington	21 times diameter of rope
for 8 x 19 Filler Wire	21 times diameter of rope
for 6 x 37 Seale	18 times diameter of rope
for 6 x 41	18 times diameter of rope

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